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EDITORIAL NOTE.

IN completing the Volume for 1896, the Editors desire to record their satisfaction at the favourable reception accorded to the Magazine in its extended area of work during the year. It is intended to pursue the same course in the new year, and while keeping abreast of the highest scientific achievements and aspirations of the time, every effort will be made to render the columns of KNOWLEDGE of abiding interest to its readers. "Simply worded—exactly described" will be the aim in the future as it has been in the past.

With the January Number will be commenced a series of illustrated papers on the Progress of Science during the Queen's unique reign, a period of time unexampled in the world's history for the scientific advancement of the nations. Arrangements have been made to enlist the aid of leading men in the various branches of science, and no pains will be spared to render the series complete in every particular.

The same Number will contain the first of a series of illustrated articles on Practical Entomology assisted by the Microscope, to be contributed by Mr. Frederick Enock, F.E.S., F.L.S., the well-known entomologist.

During the year, Mr. G. F. Hill, M.A., will continue his interesting contributions on Numismatics, dealing first with English Medals. These papers will be illustrated with full-page photographic plates. Mr. W. Botting Hemsley, F.R.S., will also contribute a series of articles on the Vegetable Products of our Australasian Colonies.

In the Natural Sciences, although no long series of connected articles, other than those mentioned above, is contemplated, the Editors have promises of many valuable papers from both old and new contributors. Mr. E. Walter Maunder, F.R.A.S., who will continue to edit the astronomical columns, has received several photographs from Dr. Isaac Roberts, F.R.S., while many other friends have promised their aid. These, together with several drawings of planets by well-known artists in this work, will be issued monthly in the form of collotype plates as heretofore.

FORECASTING FAMINES IN INDIA.

By DOUGLAS ARCHIBALD.

THE scarcity which is now developing into famine in India, caused by an unusually early withdrawal of the monsoon, draws attention to the possibility of forecasting such events.

The crucial test and ultimate aim of every true science is accurate prediction.

In physical problems, when all the antecedent causes and operative laws are known, it is usually easy to predict the result. Where, however, as in meteorology, both the causes and the laws are only partially known, and where the intrusion of unforeseen factors and combinations may occur both in time and space, prediction must at present be based more or less on empirical relations and analogy. If carried beyond the time limits of direct observation, it must be of a broad and general character, in direct proportion to the time covered by the forecast.

So far, in England, and in most European countries, weather prediction has never advanced beyond the twenty-four hour limit, and is based almost entirely on an examination of contemporaneous data and empirical relations founded on past experience, together with a modicum of rational law. In America, owing to the wide area traversed by ephemeral weather changes, the time limit is extended to thirty-six hours; and in Australia, disturbances reaching Western Australia are forecasted to arrive in Victoria about three or four days after, but this is the extreme limit.

It is beginning at the wrong end to predict the particular; but so long as the method is confined to what is taking place within the area of observation, though the deductions are made on empirical bases, they can hardly fail to reach a certain percentage of accuracy, sufficient for practical purposes.

When we extend the time limit to several months instead of hours, and, ignoring the minor fluctuations, take note merely of the general average prevalent character of the weather during the whole period, a marked departure has to be made in the system employed.

Monthly averages take the place of hourly means; contrasts and analogies between the conditions for six monthly periods preceding and embracing the monsoon periods have to be studied. The area of observation also has to be extended beyond the limits of the district dealt with, in order to determine the subsequent effects of ascertained general conditions prevailing in surrounding areas.

On such principles the Indian six monthly forecast has been founded, and its success has been sufficient to induce the Indian Government not merely to grant the funds necessary to establish fresh observations in the Persian area, but also to arrange for the transmission of cablegrams from Mauritius. By these means, the conditions which prevail in the South Indian Ocean may be reported to the office at Simla in time to be utilized for the forecast.

Although within certain limits, the summer monsoon—which bursts, after being ushered in by heavy thunderstorms, about June 6th in Bombay, and arrives at its northernmost limits some two or three weeks later—is a tolerably regular phenomenon, it is not nearly so regular both in time and quality as is commonly supposed. Its date of arrival, for example, occasionally varies as much as thirty days, while the amount of its attendant rainfall has varied from a deficiency of six inches in 1868 to a surplus of nine inches in 1893. Concentrated in one spot this latter excess would equal two hundred and eleven cubic miles of water. To give an idea of what such an

amount really means, let us suppose the excess rainfall of 1893 to be collected in a tank with a square base of eight miles a side. Then if its altitude were that of the snow line of the Himalaya, viz., seventeen thousand feet, such a tank would barely contain the total volume of excess water which fell over India during that year. Similarly, if in order to supply the defect in 1868 we imagine a hose pipe to stretch all the way from the earth to the moon, of half an acre in section and full of water, it would represent a trifle more than the above defect. If it were required to irrigate the country with this hose, in order to keep up the supply to the normal during the six months of the monsoon, the water would have to issue from the hose at the rate of fifty-five miles per hour continuously.

Moreover, although such variations, spread over the entire area, reach this gigantic amount, their local effect is relatively much greater, and produces much more disastrous effects in the dry zone inland than near the coast, where the rainfall is normally high. In this zone, which comprises the Deccan, Mysore, South Madras, Central and South Punjab, and the western section of the North-West Provinces, variations often occur amounting to several hundred per cent. of the normal supply. It is this district which, as at present, is most liable to famine-producing droughts or floods.

The method of long period prediction began some years back under the late Mr. Blanford, F.R.S., by the recognition of certain sequences which were observed to occur in the summer monsoon rains, according as the snowfall of the preceding winter on the Himalayan slopes was heavy or otherwise. A heavy winter snowfall was usually found to be followed by a light summer monsoon rainfall, and *vice versâ*.

Although this factor has latterly been found to be liable to some uncertainty and modification, owing to variations in the absolute strength, quality, and duration of the monsoon current itself, it still forms one of the leading principles by which the extension of the current to its full northerly limits is predicted.

Heavy and untimely snowfall, especially in April or May, exercises a powerful influence in preventing or delaying the extension of the monsoon over Upper India.

Another factor is afforded by the local peculiarities which are manifest in the hot weather period immediately preceding the arrival of the monsoon, and which are best estimated by means of the synoptic variations of the current barometric pressure from the normal.

At one time it was thought that these local anomalies of pressure were the chief cause of the monsoon itself, on the principle of the sea breeze towards a heated area. This was formerly alluded to as the "furnace theory." It is now, however, clearly recognized that the advance of the massive current itself is not directly the result of the hot weather over the Indian area, but that it forms part of a larger system of circulation. Its forward extension across the Equator is as much due to a *vis a tergo*, effected in the South Indian Ocean, as to a *vis ad frontem*, in consequence of changes over the Indian land area following the northward march of the sun. As soon, however, as the current is once established over India, it is found that it tends to concentrate its rainfall energy mostly over those districts where the pressure was lowest during the ante-monsoon months.

Hence this second factor is of great service in determining the local or provincial variations of rainfall, though, like the snowfall factor, the deductions have to be modified in correspondence with the precise character of the incoming current.

The last factor is the condition of the south-east trade wind of the South Indian Ocean, which is now found to be nothing else than the direct parent of the monsoon.

The *modus operandi* by which the southern trade wind crosses the Equator in May and rushes across the Indian Ocean as the south-west monsoon, which breaks on the Indian coasts early in June, has been graphically described by Mr. Eliot in a recent paper in the *Quarterly Journal of the Royal Meteorological Society* (January, 1896). We need not here allude to it further than to say that while a feeble sea breeze develops along the Indian coasts for some time previous to the monsoon burst, the latter is evidently in no sense its culminating stage. On the contrary, as Mr. Eliot substantially puts it, it is plainly due to the breakdown of the upflow over the equatorial calm belt, which allows the south-east trade wind to continue its horizontal flow across the Equator. It thus brings the vapour accumulated during its southern journey in a massive sheet, which condenses when carried up the Indian ranges and plateaux.

The only direct means of estimating the probable strength and character of this vapour current is to ascertain the character of the south-east trade wind of the Indian Ocean, south of the Equator, during April and May. It is found that this is usually maintained comparatively unaltered for some months, and is transmitted, *pari gradu*, to its defluent extension, known as the south-west monsoon of India.

Up to the present time the information has usually been derived either from the logs of ships arriving at the Indian ports from the southern seas or else by letter from Mauritius, the Seychelles, etc. Latterly, however, the Indian Government has sanctioned the establishment of cable communication to the Seychelles, and is preparing to do everything in its power to accelerate the transmission of news from the Mauritius, Zanzibar, etc.

Meanwhile, as a supplement to the direct observation of the trade current, it has been found that the monthly average barometric pressure over India is subject to periodic, long oscillations, above and below the mean. These vary from six to twenty-four months, and are usually some multiple of six months.

These waves of pressure are found to be connected with the development of the monsoon current in such a way that if the wave is rising during the month or two (April and May) preceding the south-west monsoon, the rainfall will be scanty, and the reverse if it is falling. On the other hand, if it is just beginning to rise during the month preceding the winter monsoon (November), the rains which fall in December and January will probably be above the average, and *vice versâ*. These waves occur, reversed in phase, on the south side of the Equator, and indicate, as Mr. Eliot (the head of the Indian Weather Bureau) says, checks and accelerations in the seasonal mass transfer of air across the Equator between the Indian Ocean and Southern Asia.

Twelve such waves have occurred during the past twenty years, and their careful study seems destined to open out a new departure in meteorology by permitting seasonal forecasts to be projected on a rational basis.

Regarding the forecast this year, though no direct reference was made to the possibility of a famine-producing drought, attention was drawn to the signs of a weak monsoon from the observations, particularly at the Seychelles.

Up to the present time the probability of a break in the middle of the rains or their early termination in any year are admitted to be difficult to determine with accuracy. The latter is, perhaps, one of the most important relations to be able to forecast, since the present disastrous scarcity is directly traceable to an unusual scorching in September,

when the monsoon ought still to have been exercising its moist and sheltering influence.

At the existing rate of progress, however, there is little doubt that the possibility of predicting an early stoppage as well as a diminished strength in the monsoon will be shortly within the power of the Indian Meteorologist-in-Chief; and it is to be hoped that the successful example of the bold experiment of predicting weather conditions half a year ahead in India, will stimulate European weather bureaux to advance beyond their present unsatisfactory position.

GREEK VASES.—IV.

C.—RED-FIGURED VASES (FINEST PERIOD.)

By H. B. WALTERS, M.A., F.S.A.

IN the last article (*see* July Number) we dealt with the history of Greek vase painting down to the end of the sixth century B.C., with some allusions to the changes in the art that were taking place towards the end of that century. In the present article this question must be discussed at greater length, although the sudden reversal of technical method involved in the change from black figures on red ground to red figures on black ground is not at first sight easy of explanation. We are also met with chronological difficulties, owing to the results obtained from the recent excavations on the Acropolis of Athens. Into the details of this question, however, it would be inadvisable to enter; suffice it to say that it is now acknowledged on all hands that the first appearance of vases with red figures is not, as was formerly supposed, subsequent to the Persian Wars (*i.e.*, after 480 B.C.), but must be pushed back to the time when the Peisistratidae ruled as tyrants in Athens, about 520 B.C.

As to the origin of the red-figure technique, it is susceptible of more than one explanation. We must remember that it had no development from the black-figure style, as no intermediate stage between the two is possible. There is, however, a small class of vases in which the figures are painted in *opaque* red colour on a black ground, with which the whole surface of the vase has been covered. We know from excavations that these vases belong to the period 500-480 B.C., and some may be even earlier; it is, therefore, conceivable that it occurred to the painter that it was more effective to let the red clay of the background appear through the black, wherever he would place a figure, than to paint the red on to the black. But these vases are few in number, and there is no doubt that the red-figured vases sprang at once into very great popularity, and that the new invention, however brought about, was too generally adopted at first to derive its origin from a comparatively rare method. The transformation is usually associated with a certain group of painters, who appear to have used the two methods indiscriminately, either painting whole vases with red or with black figures, or combining them on one vase.

Briefly, the method of vase painting during the period under consideration is as follows:—The artist sketches his design on the red clay with a fine pointed tool; he then surrounds this outline with black varnish, laid on with a brush to the extent of about an eighth of an inch all round, this being done to prevent the varnish when laid on over the rest of the ground from running over into any part of the design. Finally, details, such as features or folds of drapery, are added with a brush in black lines on the red; and further details are often expressed either in a thinned black pigment which becomes brown, or by application of white or purple as in the last period.

Thus we see that the technical process of the preceding method is exactly reversed, and that the figures now stand out in the natural colour of the clay against the black ground.

Throughout the period there is an extraordinarily rapid advance both in artistic conception and power of execution, due, no doubt, to the contemporary impulse given to the more dignified art of fresco-painting by the rise of Polygnotos and the other great Athenian painters of the fifth century. Yet this improvement was finally to prove the vase-painter's ruin. At first the large and simple compositions of the fresco-painters exercise a praiseworthy influence on the conceptions of the vase-artists, besides providing them with new hints for technical improvement, such as additional colours or variety of ornament. But the more truly pictorial the scenes on the vases become, the more do they tend to deteriorate in merit; the love of over-refinement and the newly-acquired skill in drawing drive the artist to produce hurried, careless compositions, and to forsake archaic severity for crowded scenes or groups of figures without meaning or interest.

Contemporary with the red-figure method is one which we have already not infrequently met, in which the figures are painted on a white slip; and this method also receives

FIG. 1.—Lekythos (Oil-Flask) of "Strong" Period: Niké (Victory) pouring Libation at Altar. About 460 B.C.

a fresh impetus in the period before us, and even more than the other brings before us the methods and processes of the great painters. It must be remembered that in the fifth century fresco painting was a comparatively simple process, three or four colours alone being employed on a white ground resembling that used on the vases. The ground in either case being of the same character, it was but a short step for the vase painter to employ the same method of colouring, even though on a vastly smaller scale.

It is true that we only possess a very few vases with designs in colours on a white ground; but such as we have are of such exceptional excellence that we are fully justified in seeing in them the best results of the influence of which we have spoken. In this connection we may note that there is evidence that at one time it was the practice to paint tombstones (*stelae*) with the effigy of the dead person in colours on a white slip, and we shall see later on that this method was by the middle of the fifth century almost exclusively adopted for a class of vases destined particularly for sepulchral purposes.

We now first find attempts to render the human body in positions other than purely profile, and to throw off the trammels of conventional archaism (such as that of Egypt), which forbade to render the chest and shoulders in profile or the face and limbs in front view. Thus the way is prepared for the development of perspective and foreshortening, which tends, as we have seen above, to the rapid perfecting of linear drawing, as exemplified in the vases of the latter half of this century.

Another circumstance which led, as in the case of sculpture, to a greater facility in rendering the human figure, was the growing familiarity with the perfections of nude male forms brought about by the increased popularity of the Olympian and other games. The prevailing tone of the subjects on the vases is no longer now mythological, but the *ephebos*, or full-grown youth, that peculiarly Attic creation, reigns everywhere supreme.

It may be convenient to pause here for a moment, and note the various stages of development through which the red-figure style passed. (1) The *archaic* shows all the stiffness and want of technical freedom characteristic of the last stage. (2) The *severe* style shows a marked attention to detail and greater technical freedom, but not as yet without stiffness. (3) The *good* period has several subdivisions: (*a*) the *strong* style, dry and vigorous, delighting in difficult subjects; (*b*) the *large* style, aiming chiefly at breadth of effect and dignity of composition; and (*c*) the *fine* style, showing the perfection both of technique and composition. (4) Finally we have the *late fine* style, introducing mannerisms and refinements, which tend to nothing more than pictorial prettiness, and degenerate into merely careless and florid work which at last fails to arouse any interest.

The shapes of the vases are, roughly speaking, the same as those of the last period, but certain developments of form can be traced, and some shapes are more in demand at certain stages. For the first half of the century the most characteristic form is the kylix or two-handled cup, with wide shallow bowl on a high stem. Another important shape is the hydria or three-handled pitcher, which exchanges its somewhat angular outline and flat shoulder for a gracefully curved form, in which the neck merges in the shoulder, and that again in the body, making one single curve throughout. Instead of two subjects, as in the last period, we now only have a group of two or three figures on the body. The amphora loses much of its popularity, with the exception of some early examples which reproduce the character of the black-figured amphoræ; but a new and very charming variety appears. This is known as the Nolan amphora, from the fact that it appears to have been a popular shape with the inhabitants of Nola in Campania, as many examples have been found there, imported from Greece. Its characteristics are: a slim body and long neck, handles reeded and often twisted, a very fine and lustrous black glaze, and a design confined to one or at most two figures on either side. A second popular variety of the amphora is the *pelike*, in which the foot disappears, and the body swells out from the handles downwards, with a somewhat clumsy effect. Another characteristic shape of this period is the *stamnos*, a wide-necked full-bodied jar with small side handles, which only found favour for a short period, but that the time of the best artists.

In the later stage of the red-figure style the larger and bolder varieties appear to be discarded in favour of small

Fig. 2.—Lekythos (Oil-Flask), with Polychrome Figures on White Ground; made for use at a Funeral. Subject: the Deceased Person at her Toilet.

and elegant shapes, among which we may mention the *aryballos* or *lekythos* with globular body; the *pyxis*, a cylindrical box with cover; and the *askos*, a small oil-flask with handle and spout, which did not afford much scope for decoration. But the aryballos and pyxis (*see* Plate, No. 6) supply some of the finest examples of the "late fine" period, even though the subjects are sometimes fanciful or the drawing over-refined; moreover, considerable effect is gained by the judicious addition of gilding, white or blue, and other colours.

The subjects on red-figured vases may not, perhaps, be regarded as so varied or interesting as those on the black-figured, but still are worthy of all attention. At the very outset we see a tendency towards scenes of real life, instead of the old mythological repertoire. At the same time, scenes from epic legend and mythology hold their own with almost as much variety as before, but it is remarkable to note how the well-worn types, which we discussed in the last paper, are promptly discarded, and how, with his new-born capacities of drawing and free scope for composition, the painter is led to form his own idea of the subject he wishes to depict, without regard to the lines on which his predecessors worked. In the next stage, or "strong" style, the patriotism of the Athenian artist finds expression in the growing importance which he attaches to purely

1.—Kylix (Goblet), signed by Epiktetos.

2.—Kylix, signed by Euphronios.

5.—Krater (Mixing Bowl), of Fine Style.

4.—Kotylé (Beaker), signed by Hieron.

3.—Kylix, signed by Brygos.

6.—Pyxis (Toilet Box) of Late Fine Style.

GREEK VASES.

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Attic legends, especially those of Theseus, the typical Attic hero. Two causes combined at this time to bring Theseus prominently forward among the Athenian people. Firstly, that he was supposed to have appeared in aid of their side at the battle of Marathon; and, secondly, that in 469 B.C. his bones were brought by Kimon from the island of Skyros, and buried with great solemnity in the Theseion, which building was decorated with paintings also celebrating the hero. It is also probable that Theseus was regarded as the typical athlete and the typical Attic *ephebos*, and his contests as analogous to successes in the *palæstra*. Hence the grouping of scenes from the labours of Theseus after the manner of groups of athletes variously engaged.

In the "fine" style the athletic subjects reach the height of their popularity, and Dionysiac subjects are also fairly common; but there is a certain reaction in favour of mythological subjects, such as battles of gods and giants, or the sending forth of Triptolemos from Eleusis by Demeter (a very characteristic subject of this period; *see* Plate, No. 4). Scenes of banqueting and revelry, or mere groups of figures conversing, are more popular on the cups of this period—the mythological subjects on the amphoræ and other large vases.

In the "late" style the popularity of athletic subjects begins rather to wane, and the private life of women comes more to the front. Again, we have many merely fanciful scenes, or figures with fanciful names drawn from mythological sources at haphazard.

But, for the student at any rate, the inscriptions on red-figured vases offer even more interest than the painted designs. Besides those that we may call descriptive, *i.e.*, which relate to the subjects depicted, we find numerous inscriptions which have a wider and more external interest. These fall into two classes: artists' signatures, and names of favourites. The special value of these inscriptions to the student is that he is thereby enabled by comparison of signed and unsigned vases to attribute many of the latter to known artists; while in the case of vases which merely bear the names of favourites, the fact that certain of these names are elsewhere associated specially with certain artists allows these vases to be assigned to their sources with even more certainty.

It should be explained that a favourite name denotes the name of some personage with the word καλός, "fair" or "noble," attached; implying that the painter wished to celebrate either some popular man of the day or some much-admired youth. The exact meaning of this practice has been much discussed, the chief difficulty arising from the fact that though many names famous in history, such as Miltiades, Alcibiades, and Hipparchos, occur among the favourites, it is impossible to discover whether they really refer to the historical personages or not. It is clear that if this identity could once be proved, we should have certain chronological data which would be of immense value for the history of vase painting; at present, however, we must be content with using the favourite-names for the identification of particular artists.

The artists whose signatures are known to us fall into three well-defined groups, corresponding to the divisions of style given above. They are as follows:—

(1) The group of Epiktetos, corresponding to the "archaic" style, and including several artists who employed both black and red figures.

(2) The group of Euphronios, corresponding to the "strong" style, and including the best work of the period, especially as far as the kylikes are concerned.

(3) The later Attic group, corresponding with the "fine" style.

The best work of these artists is, as a general rule, to be seen on the kylikes. The productions of Epiktetos and his fellow craftsmen are chiefly characterized by simplicity of conception, the natural consequence of the recent change from the old method. (*See* Plate, No. 1.)

Euphronios, as we have indicated, is usually associated with the most perfect work of this period. His style is characterized both by grandeur and beauty, combined with elegance and ease in composition, and a careful attention to the smallest details. (*See* Plate, No. 2.)

Among his contemporaries, Duris, Hieron, and Brygos take front rank, each, however, being an artist of marked individuality. The chief feature of Duris' work is a preference for quiet gracefulness rather than violence of action, and a love of slim nude figures. The vases of Brygos are comparatively rare, but we are able to see that he stands on the threshold of the next stage, and while still retaining certain traces of archaism, yet shows in his fondness for realism and copiousness of detail a rapid advance towards the freedom of the fine style. (*See* Plate, No. 3.) Hieron, again, is not a man of much originality; his tendency is chiefly to sentimental figures and idealized scenes of daily life. (*See* Plate, No. 4.)

The later group need not detain us long. Hardly any of these artists have left more than one specimen of their work, but Aristophanes has signed a beautiful kylix, with scenes from the battle of the gods and giants; and Sotades has produced several very delicate drinking-cups of various fanciful forms, some painted with designs of great beauty and refinement. A hydria, the work of Meidias, is also justly celebrated for the richness of its decoration and delicacy of execution.

We have alluded above to a class of vases with paintings on white ground which was produced exclusively for sepulchral purposes. With a few exceptions from Gela in Sicily, Locri in Southern Italy, and Cyprus, these vases have been all found at Athens or Eretria in Eubœa, and there is little doubt that they were all made at Athens. Their development is parallel to that of the sculptured tombstones, of which such a great number have been found at Athens, and the subjects are similar, but more varied. The commonest type of subject is that of mourners bringing offerings to the tomb of the deceased, represented by a tall monument on a raised base; the offerings take the form of vases, sashes, etc., for the decoration of the tomb. Other scenes depicted with less frequency are: mourners bending over the death-bed; the deceased person conveyed in Charon's boat over the Styx; a dead warrior laid in his tomb by Death and Sleep. In another group the funereal purpose of the vase is only hinted at: the deceased is represented, if a man, hunting or in armour; if a woman, engaged in some feminine occupation; the idea being, as we see it on the sculptured tombstones, to suggest the dead person as he was wont to be occupied in his daily life. (*See* Fig. 2.)

The period covered by these vases ranges from about 450 to 300 B.C.; many of the later examples are carelessly executed with rapidly-applied patches of colour, and suggest that the vases had been hurriedly produced "to order" on the occasion of the funeral. They were placed round the bier at the laying-out of the corpse, and then buried with it.

For all practical purposes the red-figured style may be said to have an end with the fall of Athens in 404 B.C. It is true that many existing vases can be dated later, as, for instance, the sepulchral lekythi, of which we have just been speaking; but they are exceptional, and all other vases which cannot go further back than the fourth century must be regarded as belonging to the period of the decadence, even though many of them were made at Athens, or directly under Athenian influence. But none

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of the finer examples of red-figured vases can be later than B.C. 400, while historical evidence taken in conjunction with the results of excavations in Sicily and Rhodes, and at Naukratis, points to the fact that apparently late red-figured vases found in those places cannot be later than the fifth century.

DESCRIPTION OF PLATE.

1. Kylix (goblet), signed by Epiktetos. In interior, man playing flutes and girl dancing. About 500 B.C.
2. Kylix, signed by Euphronios. In interior, elderly man and girl conversing. About 480 B.C.
3. Kylix, signed by Brygos. In interior, woman giving drink to departing warrior. About 460 B.C.
4. Kotylé (beaker), signed by Hieron. Subject symbolical of the introduction of agriculture into Attica: Triptolemos sent forth by Demeter from Eleusis. About 470 B.C.
5. Krater (mixing bowl), of fine style. Subject: Sunrise, represented by the sun-god in his chariot and four boys diving (indicating stars setting). About 440 B.C.
6. Pyxis (toilet box), of late fine style. On the top, the death of Pentheus; round the side, the chariot of Aphrodité drawn by two attendant genii. About 420 B.C.

SOME CURIOUS FACTS IN PLANT DISTRIBUTION.—VI.

By W. BOTTING HEMSLEY, F.R.S.

IN the first of this series of articles (February, 1896) some particulars were given of the latitudinal distribution of flowering plants. It was shown that, with one possibly doubtful exception, no flowering plants existed in the remote islands of the southern hemisphere within thirty-five degrees of the Pole, and probably nowhere within thirty-four degrees; whereas in the northern hemisphere about seventy species had been collected between latitude 80° and 83°, or within seven degrees to ten degrees of the Pole. It was further pointed out that the plants of the southern limits of vegetation have very small green or dull-coloured flowers; whereas, in the north, showy flowers are not uncommon, coexisting with bees and butterflies. Everybody knows that plants, like animals, are affected by temperature, and it has been ascertained by observation and experiment that a certain amount of temperature is necessary for the perfect development of a plant, the amount varying for different plants. Some trees and shrubs that thrive in this country rarely, if ever, flower; others flower, but never, or very seldom, produce seed. This difference in constitution is a problem difficult of solution. The dahlia and heliotrope, the potato and kidney-bean, all attain full development in this country during the warmer months, but their constitution appears to be the same as when they were first introduced, or the same as newly-imported strains, for a very slight frost destroys their tissues, and a healthy plant is thereby reduced, in less than twenty-four hours, to a black decaying mass. To look at, a seedling groundsel is as delicate and tender an organism as a seedling cucumber; yet the seed of one will germinate and grow in a temperature a few degrees above the freezing point, whilst the other requires a considerable amount of heat, and only really flourishes in the open air in England during our most favourable—that is to say, our warmest—summers. On the other hand, there are some plants of a hardy nature that will grow under widely different atmospheric conditions. In other words, the difference between the maximum and minimum sums of temperature under which they will fully develop is very large. Other plants will bear one or more sharp frosts without much injury, but a long continuation or succession of sharp frosts will kill them. Perpetual frost would, of course, eventually destroy all plant life, because it prevents growth. But in Arctic and Alpine regions—in fact, in nearly all cold countries—vegetation is protected by snow, and it may be said in a general way that the temperature of the soil is higher in cold weather and lower in hot weather than that of the air. Other plants are prevented from dying out, through exposure to excessive heat, or cold, or drought, by the fact that, although they flower only once, they produce seed in abundance. The seeds of such plants will bear exposure to the greatest solar heat, or to intense frost, or to the most prolonged droughts, without losing their vitality. These general explanations will render intelligible the existence and reproduction of plants under conditions that one might otherwise consider destructive of living organisms, whether animal or vegetable.

Generally speaking, the same causes determine the character and composition of vegetation in high altitudes as well as in high latitudes.

In the extreme land limit reached by the British Polar Expedition in 1876 flowering plants were found, and there is every reason to suppose that if there were land at the Pole itself there also plants would exist. Ward Hunt Island, 83° 4′, and Cape Columbia, 83° 8′, were the most northern points at which plants were collected. In the latter locality grew *Saxifraga oppositifolia*, a charming little plant that inhabits the mountains of the British Islands, and also grows freely under cultivation down to the sea-level in the South of England. It is found throughout the Arctic zone, and has an exceedingly wide range outside of the Arctic regions, in the mountains of Europe and Asia, including the Himalayas, up to an altitude of seventeen thousand feet.

In this connection it is worthy of note that a saxifrage (*Saxifraga Boussingaultii*) has been found at as great an altitude—namely, sixteen thousand five hundred feet—if not greater, than any other flowering plant in the Andes of South America. When this discovery was made, it was supposed that there was little probability of any flowering plant being found at a greater elevation in any part of the world, especially as the locality is close under the Equator; but, as will be presently shown, plants have since been discovered at much greater elevations.

It is singular, too, that another member of the same genus (*S. bicuspidata*) reaches the southern limit of flowering plants in Hermite Island, Cape Horn. This species is remarkable for its very small flowers, and the forcep-like appendages at the tips of the leaves, very similar to those of an earwig.

Papaver nudicaule, commonly cultivated and known as the Iceland poppy, was collected on Ward Hunt Island. This also ranges all round the northern hemisphere, but it is not wild in the British Islands.

Altogether, thirty species of flowering plants were collected north of the eighty-second parallel of latitude, and about half of them are British.

As to the conditions under which plants grow in these high latitudes, and the forms they assume, it may be stated generally that they gradually diminish in size and frequency; that they never produce ripe seed, and therefore only increase by their creeping stems, above or below the surface of the soil. The vegetation on the northern slopes is more luxuriant than on the southern, because it gets more sun on that side. Observations on the vertical range of plants in Discovery Bay (81° 42′) gave two thousand as the maximum. To this altitude the poppy, two species of saxifrage, and a kind of whitlow grass ascended. Indeed, vegetation is limited by the line of perpetual snow, varying greatly in different localities.

Scanty as the herbage is, a variety of animals subsist

entirely on vegetable food, such as the lemming, hare, goose, musk ox, and reindeer.

Although no seed is produced in the higher latitudes, seed taken there germinated and grew during the summer in a temperature almost constantly as low as thirty-three degrees Fahrenheit. As no seed is produced, it follows that the present Arctic vegetation must be the remnant of a former more extensive flora; but, apart from this fact, there is abundant fossil evidence, both animal and vegetable, of very different conditions from the present.

Another curious point in connection with Arctic vegetation is the fact that only the surface of the soil thaws during the short summer, so that the roots of plants are in a medium bordering on the freezing point. This phenomenon may occasionally be seen exemplified in this country, where one portion of a grape vine, for example, is under glass and the other out of doors. The sheltered part, in spite of external cold, will grow and produce fruit, whilst the exposed part will remain dormant until spring.

I have not much space left for the discussion of the altitudinal limits of flowering plants, but a few of the leading facts will suffice. Contrary to what might have been expected, considering the latitude, it is in the region of the greatest elevation—in North India and Central Asia—where flowering plants reach the highest levels of any part of the world. The comparatively recent explorations of Conway, Rockhill, Thorold, and others, have yielded some highly interesting results. The collection made by Dr. Thorold may be taken as an illustration of this high-level vegetation. Dr. Thorold accompanied Captain Bower across Tibet from west to east, from Ladak to China. The route lay between 30° and 34° north latitude, at an average altitude of fifteen thousand feet, or about the same as the summit of Mont Blanc. As may be imagined, the climate is very severe and the vegetation exceedingly scanty; yet upwards of a hundred species of flowering plants were collected, with few exceptions belonging to genera represented in the British flora. Considering the altitude, this number is large as compared with what is found in other parts of the world; but when we reflect that as many species may be found on an acre of ground in this country, and that those hundred or so species were the fruits of five months' march through twenty degrees of longitude, we begin to realize the extreme poverty of the flora. Throughout this long journey, not a tree, not even a bush, was seen; none of the plants were more than a foot high, and most of them not more than two or three inches. They nowhere formed a carpet, but occurred singly or few together, and at long intervals. Plants having large descending roots, a rosette of leaves flat on the ground, with flowers nestling close in the centre, are characteristic of this region. Many of these belong to the thistle family. There are also buttercups, larkspurs, poppies, scurvy grass, saxifrages, asters, dandelions, wormwoods, primroses, gentians, and grasses. Contrary to what is the case in the Arctic regions, about half of the species are peculiar to this great upland country. About sixty of them were collected at altitudes between seventeen thousand and nineteen thousand feet, and of these half a dozen were found above eighteen thousand feet. One only was met with at nineteen thousand feet. This is *Saussurea tridactyla*, a plant densely clothed with woolly hairs. A species of the same genus inhabits the mountains of the North of England and Wales.

[In the series of articles of which this is the last, I have almost confined myself to a statement of facts of the present distribution of plants over the surface of the earth. I have pointed out that the domestic weeds and cornfield weeds of Europe have spread in temperate and sub-tropical countries almost as widely and rapidly as man, for the greater part unintentionally introduced by him with the seeds of his cultivated plants; and I may add that there has been no counter current to speak of. This is to be accounted for by the fact that in the uncivilized countries now colonized by European races, there was little or no cultivation and there were no roads; consequently there were no plants that had adapted themselves to the conditions of life connected with civilization. It is true that a few exceptions might be named, but they prove the general statement. Many readers, doubtless, will remember the American water-weed (*Anacharis canadensis*), which invaded this country about fifty years ago, and spread at such a surprisingly rapid rate that it soon choked ponds, ditches, and brooks from one end of the country to the other. This has since lost much of its former vigour, and is now more easily combatted.

I also alluded to the planting of remote islands by means of oceanic currents, tidal waves, and birds conveying seeds which retain their vitality after long immersion in sea water, or after passing through the intestinal canal of a bird. But these agencies, much as they may have effected, count for little as against the great physical changes which our earth has undergone during the countless years which must have elapsed since the first fossil remains were deposited and petrified, which now serve as history—undated, it is true—of a past that is unfathomable.]

OUR FUR PRODUCERS.—VI.

RODENTS, UNGULATES, AND MARSUPIALS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

NUMERICALLY a high position in the fur trade is occupied by the skins of certain species of the order of rodents, or gnawing mammals, although several of these are of little value individually, and their importance in the market is solely due to the numbers in which they are collected. Among such rodents we may first notice the common squirrel, which has an extremely wide geographical range, extending from England in the West to Japan in the East, and reaching northwards to Siberia. In the first half of the century the trade in squirrel skins was enormous, over two and three-quarter millions having been imported into this country in the year 1839. Since that date the numbers have declined, although it is at present impossible to obtain exact data; but that the trade is even now very considerable may be gathered from the fact that the annual import from Ockotsk alone to London varies from fifty to a hundred thousand. Squirrel skins are subject to considerable variation in colour according to locality, those from the Russian province of Kazan having the red tinge very strongly pronounced, while to the east of the Urals greyer species are met with; and in parts of Siberia and Japan the general colour is slaty blue or blackish, the ears and tails being almost entirely black. The darker the fur the greater the value of the skin. The great squirrel-dressing centre is Weissenfels, in Germany, where some establishments prepare half a million skins annually. The skins are cut up into backs, bellies, and tails; and while the first of these are used for capes, trimmings, and the linings of gloves, the second form the bluish white linings of opera and other cloaks. Tails, on the other hand, are made up into fringes for mantles, or into boas; while the hair, when removed, is used for the manufacture of the so-called camel's-hair paint brushes. Although a few of the larger skins are dyed in imitation of marten, squirrel

fur is nearly always used of the natural colour; but, as it will felt, it is occasionally employed in the manufacture of hats.

Although a few skins of the small Indian striped squirrel (*Sciurus palmarum*) and of the American grey squirrel (*S. carolinensis*) find their way into the market, the next species of any commercial importance is the red squirrel, or chickari (*S. hudsonianus*), of North America. Like the next, it is chiefly used for the cheaper kinds of mantles.

Head of Bull Musk Ox.

The small, burrowing, Russian animal, allied to the squirrels and known as the suslik (*Spermophilus citillus*), has only recently come to form an item in the fur trade, but we have no record of the amount of the import.

The harshness of their fur renders the skins of the marmots (*Arctomys*) but ill adapted to the requirements of the furrier. Nevertheless, as many as fifty thousand pelts of the Russian marmot (*A. bobac*) have been imported in a single year, while of the American species (*A. monax*) some four or five hundred come into the market. Some thousand skins of Arctic marmots are also sometimes imported. They are generally used for rugs, although some are dyed brown and made up into capes.

In the old days, when its fur was used in the manufacture of "stove-pipe" hats, the American beaver was one of the most important of all mammals in the fur trade, but this manufacture has almost entirely ceased. Still, the importation of skins is even now very considerable, and would doubtless be larger were it not that the numbers of the animal have been so reduced by constant persecution. In the year 1891, Mr. Poland states that over sixty-three thousand beaver skins were sold by the Hudson Bay Company. At the present day the skins are used either in the natural state, or with the longer hairs removed so as to display the under-fur, while in some cases they are dyed brown or black. Sometimes they are "painted" by the introduction of white hairs to imitate sea-otter, and in some instances they are silvered at the tips by means of acid. When finished, they are usually worked up into trimmings, cuffs, or muffs, but a few clipped skins are used for glove-tops. In Europe the beaver is too nearly exterminated for its fur to be of any commercial importance.

Although a few skins of the Australian water-rat (*Hydromys*) are from time to time imported, the next animal on our list is the well-known European hamster (*Cricetus frumentarius*), which is a member of the great mouse tribe (*Muridæ*). Many thousands of pelts are yearly imported into England, which may be recognized by their varied colours, the upper parts being mostly brownish grey, with blue under-fur, while the lower surface is black. Of far more importance is the American musquash, or musk-rat (*Fiber zibethicus*), which is a near ally of our own water-rat, and yields a beautifully soft fur varying in colour from umber brown to black. Upwards of three or four million skins yearly come into the market, the Hudson Bay Company having alone sold more than half a million in 1891. Twenty years ago nearly four shillings each were paid for the best black skins, but the present price is less than two. They are made up either in the natural state or dyed black, or some shade of brown; while a certain number are "pulled" and dyed to imitate sealskin.

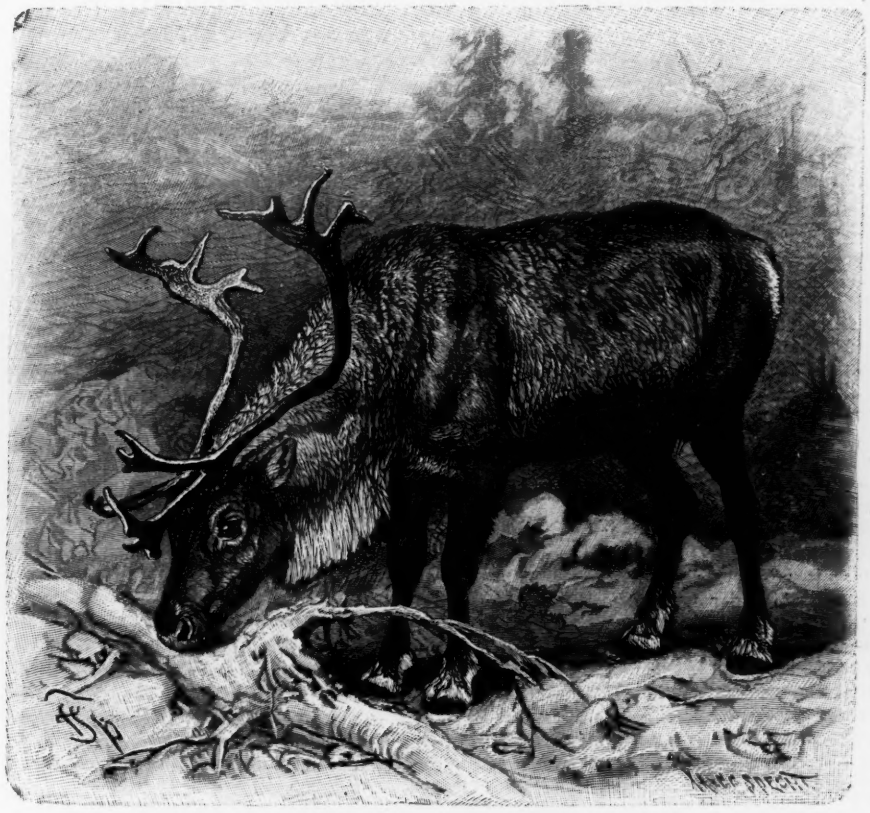
The next important rodent in the fur trade is the South American coypu (*Myopotamus coypu*), a large animal with somewhat the habits, colour, and appearance of a beaver, but with a tail of ordinary proportions, and bright red incisor teeth. It is, however, no relation to the beaver, but belongs to the great family of the *Octodontidæ*, most of the members of which are South American, although a few are African. Both in its native land and in the fur trade the animal is known as *nutria* (the Spanish name for otter); and the skins are removed by slitting up the middle of the back, so as to preserve intact the fine fur of the under surface. From three hundred thousand to half a million skins are annually collected. Either in the natural condition or "pulled," the fur is dyed dark brown or black; and in the latter condition forms one of the best imitations of sealskin. Sometimes the "pulled" fur is silvered to imitate sea-otter.

The most beautiful and, for its size, the most valuable of all South American rodent furs is, however, that of the little chinchilla (*Eriomys chinchilla*) of the Andes, which belongs to the exclusively South American family of the *Lagostomatidæ*, typically represented by the viscacha of the Argentine pampas. Chinchilla fur is the finest and most

delicate of all furs, and is generally of a pearly French grey tint, although white, and less commonly drab, varieties occur. The animal is, however, but small, measuring only about nine inches to the root of the rather long tail; so that many pelts are required to make a garment of any size. From five thousand to eighty thousand is stated to be the number of skins annually reaching this country; and many more are used in South America. Tippets, capes, and muffs of chinchilla fur are highly appreciated, and nearly always in fashion. Viscacha fur, although soft in texture, is not durable, and therefore unfit for the purposes of the furrier.

The only other rodents of importance in the fur trade are the various species of hares and the rabbit. Of the number of skins of the common hare (*Lepus europæus*) that annually come into the market, it is impossible to form any accurate estimate, although it is certain that it must be enormous. The value per skin is, however, trifling. More valuable are the pelts of the mountain hare (*L. timidus*) of Northern Europe, and of the nearly allied Polar hare (*L. arcticus*) of the northern regions of the New World, in both of which, when the cold is sufficiently intense, the fur turns white in winter. From Russia alone between two and five million pelts of the European species are imported, a large proportion of which are in the white winter coat. In regard to these, Mr. Poland writes that a large number "are used for fur purposes, both natural white, in imitation of white fox, and dyed lynx colour, brown, dark brown, black, and snowflake. The peculiar dye called snowflake is produced by passing a solution of wax over the points of the fur, and then dying the under-fur a beautiful brown. The tips of the hairs thus retain their natural white colour. The wax covering is removed, the skins are cleaned, and the fur has then a beautiful appearance somewhat like silver fox." Of the brown American hare (*L. americanus*), which is a more southern form than the Polar hare, nearly ninety thousand skins were imported in 1891.

On account of its extreme cheapness, rabbit fur is one of the most widely used for common purposes of all, although it is by no means durable, and soon begins to show signs of wear. The total annual collection from all parts of the world must be something enormous, France and Belgium accounting for about two millions, while the English skins are stated to average thirty millions. With the exception of that of the musquash and squirrel, the fur of the rabbit is used more extensively than that of any other animal. When clipped and dyed, it is used in imitation of various other furs of much higher value—such as seal and beaver—while some white skins are dyed snowflake.



Reindeer. One-fifteenth natural size.

Of mammals belonging to other orders whose fur is of any commercial importance, space compels our notice to be of the briefest. The Insectivora lay claim to only two species that come within this category, the first of these being the common mole. Although mole fur is exceedingly soft and beautiful, the small size of the skin renders it much less valuable than would otherwise be the case, and consequently only a few thousand skins are annually collected. The other species is the Russian desman (*Myogale moschata*), an aquatic animal, with a long trunk-like muzzle and dark purplish fur, which may be compared in size to a large water-vole. Between six and twelve thousand skins is stated to be the annual collection of this species. They are chiefly used as trimmings for mantles, and less commonly for glove-tops, but find more favour in America than on this side of the Atlantic.

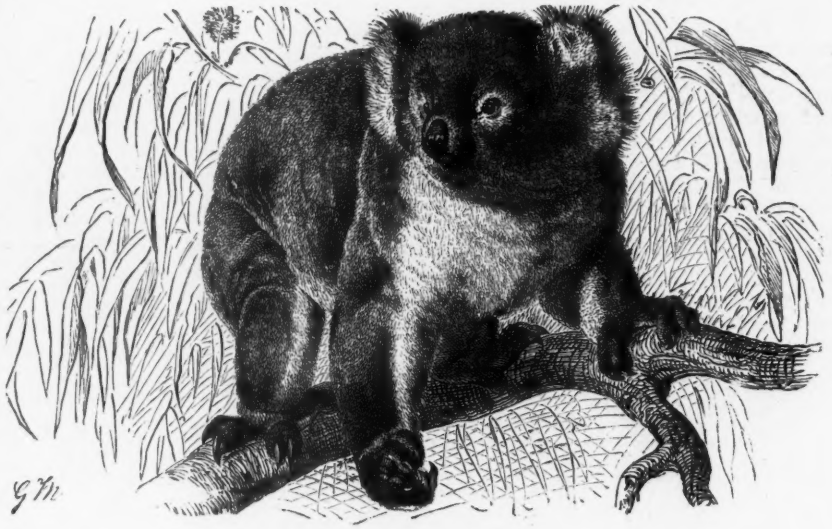
Although many members of the hoofed, or ungulate, order are fur producers in the widest sense of the word, their products are in several cases mainly employed in the manufacture of textile fabrics, and accordingly do not come within our province on the present occasion. Of the species yielding a true fur, one of the most important was the American bison, or, as it is incorrectly called, buffalo. Although formerly the annual collection of "buffalo robes" amounted to between one hundred and fifty thousand and two hundred thousand, while as late as 1879 fifty thousand were obtained in the United States, and nearly three

thousand robes and skins imported into London, the trade, owing to the practical extermination of this fine animal, has entirely come to an end. From their warmth—greater than that of any other fur—buffalo robes proved by far the best of all sleigh wraps. An excellent substitute is, however, now found in the skin of the musk-ox (*Ovibos moschatus*) of Arctic America. Although there is a very large trade in antelope skins for leather, but few of these are used as fur. Handsome rugs are, however, made of sprinbuck pelts, the line of long erectile white hairs down the middle of the back forming a pleasing contrast to the general chestnut tint of the fur. Of late years a considerable trade has sprung up in rugs made of grey goats' skin, which come from China; and the pelts of the long-haired Russian goat, when dyed, are employed for a similar purpose. More valuable are those of the Angora goat, in which the pellage is still longer and softer. The trade in China goatskin rugs is, however, still more extensive, four hundred thousand having been imported in a single year, and these representing more than double that number of animals. Mongolian goat-skins exceed even these in number, the import reaching to between thirty and eighty thousand.

To give any adequate account of the use of the pellage of the various breeds of sheep in the fur trade would far exceed our limits, and a few words must accordingly suffice. Those skins with the longest and curliest wool are used, when dyed, for fringes and tassels; such as have a shorter staple are made into mats and rugs; whilst the shortest of all are made into saddle-cloths for our cavalry. Even more extensive is the use of lambskins—especially those of newly-born animals—these being employed for glove-linings, the trimmings of coats, and the lining of those Eastern coatlike garments known as postins. The finest of all are the Persian and Astracan skins, both of which take a brilliant black dye, and are soft, short, and beautifully curled. Canada and the United States are now the great marts for astracan, this fur not being in fashion at home.

Of the deer family, the only one of much importance from our present point of view is the reindeer, the skins of which furnish the entire dress of the Lapps and Eskimo. Some eight hundred skins of the American variety are yearly imported into London, and are sent to be dressed in Germany. Of these the youngest and finest find much favour in Russia as linings. The other fur-bearing ungulates are all South American, and include the domesticated llama and alpaca, and their wild allies the guanaco and vicuña; all being near relatives of the camels of the Old World. The domesticated kinds are mainly kept as beasts of burden, and for their wool; but the guanaco and vicuña yield a beautiful pale fawn-coloured fur, much esteemed as rugs.

But few lines remain for the consideration of marsupials as fur producers. Most important of all are the so-called opossums of Australia, which, as our zoological readers are doubtless aware, are not opossums at all, but phalangers (*Trichosurus*). The beautiful soft grey fur of an opossum rug is too familiar to need any description,



Koala. One-sixth natural size.

and it must suffice that the total import of opossum skins into London in 1891 reached the enormous total of three millions. These comprise varieties from different districts.

Although the name of opossum has been usurped in the fur trade by phalanger skins, the true American opossums (*Didelphys*) are by no means unknown. Of the common opossum, between two hundred thousand and three hundred thousand skins are annually imported. Although somewhat coarse, the fur is thick and durable; and, either in the natural state or dyed of some dark hue, or grey, is largely employed for such articles as muffs and capes.

Of the other Australian marsupials, the most important in the trade is the koala, or native bear (*Phascolarctus*), a climbing creature with greyish fur, and the longer hairs tipped with white. In 1889 no less than three hundred thousand skins were imported, although the number is generally considerably less. Next to the koala comes the carnivorous spotted dasyure (*Dasyurus viverrinus*). The chief use of this fur is for linings. Another group of Australian fur-yielders are the ring-tailed phalangers (*Pseudochirus*), of which from two to three thousand pelts are imported. Of the various kinds of kangaroos and wallabies an enormous number of skins are collected, but as a very large proportion of these are consigned to the tanner, it would be useless to give any numerical details. Of the younger and smaller kinds the fur is employed for rugs and coats.

Had we more space at our disposal much fuller details concerning the fur trade might have been given. Sufficient has, however, been stated to show how the earth is ransacked from Pole to Pole in order to obtain the most beautiful of these lovely products, and also to indicate how enormous is the destruction of animal life due to this trade alone. May we hope that, while there is yet time, civilized Governments may unite in taking measures to prevent the extermination of any more species by a foolish greed?

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

STAR SYSTEMS.

To the Editors of KNOWLEDGE.

SIRS,—Considering the great distance which must separate the second-magnitude stars in the Great Bear (for the parallax does not seem to be in any case considerable), it seems very improbable that they constitute a system. Determinations of small proper motions are always unreliable, and with none of these stars is the proper motion large. But agreement, even in large proper motions, is often found (though, of course, not quite exact) in cases where the stars do not form a system. Thus the proper motions of three of our first-magnitude stars are as follows (I take them from the Cincinnati Catalogue) :—

	Proper Motion.	
	R.A.	Declination.
Sirius	− 0·037	− 1·20
Procyon	− 0·047	− 1·03

And Arcturus is not very dissimilar, viz., R.A. −0·080, declination − 1·98. Looking through the Cincinnati Catalogue I get the following smaller stars with motions very like the foregoing, all of which are much over the average :—

	R.A.	Declination.
Lalande 30044	− 0·030	− 1·39
Lalande 30694	− 0·049	− 1·49
Lalande 31055	− 0·062	− 1·15
36 Ophiuchi	− 0·039	− 1·18
Oeltz-Arg. 17415	− 0·069	− 1·25
W. 23h. 175	− 0·035	− 1·21

There is a small star near 36 Ophiuchi whose proper motion is almost identical with it. Can we suppose that all of these stars, or even any considerable proportion of them, belong to the same system? The proper motion of the last-named star and of 36 Ophiuchi agrees almost exactly with that of Sirius, but their situations in the sky are as follow :—

	R.A.	Declination.
Sirius	6h. 41m.	− 16° 37′
36 Ophiuchi	17h. 9m.	− 26° 27′
W. 23h. 175	23h. 12m.	− 14° 22′

The three Lalande stars 30044, 30694, and 31055 are probably really nearer to each other than the stars in the Great Bear. I might, perhaps, have added 61 Virginis to the foregoing list.

Probably a very considerable part of the apparent proper motion of a star is due to the sun's motion in space. The effect of this will be different when the stars differ in position. The apparent motion will moreover be, *ceteris paribus*, increased in the same proportion as the parallax; and of two stars which apparently agree one may be at double the distance of the other with half the parallax. But until we know the motion of each star in the line of sight we are further at sea. The effect of this may be to render the real motion of the two stars which we are comparing altogether different.

Among the proper motions of many thousands of stars there must be a large number of chance coincidences. It is only when there is something exceptional in the proper motions, or in the position of the stars which we are comparing, that we can draw any inference. Thus, I think, though no satisfactory orbit has yet been determined for 61 Cygni, we may conclude that the pair are physically connected. For the motion is exceptionally large, the stars lie close together on the sphere, and it seems to be ascertained that they have almost the same parallax. Indeed, they seem to be in reality so near each other that their mutual attraction must seriously affect the motions of both. W. H. S. MONCK.

A VERY EXTENDED STREAM OF SUNSPOTS.

To the Editors of KNOWLEDGE.

SIRS,—I have been much interested in the article on "A Very Extended Stream of Sunspots," in the November Number of KNOWLEDGE, and in the exquisite illustrations accompanying it.

Perhaps your readers may like to know that this wonderful outburst did not return when due after rotation, with the exception of a very small spot in the same position, or nearly so, as the "herald spot" alluded to in that article, although a vast expanse of faculæ, visible on the eastern limb of the sun's disc, and again on the western limb, testified to the dying embers of the great disturbance.

If I may be permitted to criticize, I should like to enquire the special meaning attached in this case to the term "nebulosity," which does not seem quite applicable to the small fragmentary spots indicated, yet can hardly be intended to signify the faculous light sometimes apparent even when the spots are far advanced towards the centre. The word "bivalve," on the other hand, as applied to segmented spots, is singularly appropriate in describing a type very distinct and of frequent occurrence.

This stream was observed, and drawings, as well as photographs, secured, by the members of the Solar Section of the British Astronomical Association during eleven days out of the thirteen during which it was visible.

E. BROWN.

[By "nebulosity" I wished to indicate the ill-defined, faint, dusky markings seen in some parts of the great group in its earlier days.—E. WALTER MAUNDER.]

VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—Since the article on the above subject, which appeared in the August Number of KNOWLEDGE, was written, Dr. Chandler's "Third Catalogue of Variable Stars" has been published. It may therefore be interesting to note the progress recently made in this branch of astronomy, by comparing this catalogue and the preceding one. The total number of variable stars in the Third Catalogue is three hundred and ninety-four, against three hundred and forty-three in the Second, and one hundred and eighty-seven in Mr. Gore's Catalogue of 1886. Thus fifty-one stars have been discovered or confirmed in the interval between the Second and Third Catalogues, a noteworthy addition to our knowledge in this department. In fact, if we go on advancing at the same rate in the future, it is very probable that the number of variables may exceed the number of the known asteroids.

The comparison in the classification of the stars is as follows :—

	Cl. I.	II.	III.	IV.	V.	Total.
Second Catalogue and Supplement	11	239	31	47	15	343
Deduct not confirmed	—	4	—	1	—	5
	11	235	31	46	15	338
Add since discovered	2	47	—	6	1	56
Third Catalogue	13	282	31	52	16	394

The classes have the same signification as in the article alluded to, viz. :—

I. Temporary or new stars.
II. Variation of one hundred days and upwards.
III. Irregular.
IV. Variations of less than one hundred days.
V. Algol type.

The long-period variables continue their superiority in numbers, while only two new and one Algol type have been added.

As regards distribution in hemispheres, there are now

one hundred and ninety-six in the northern hemisphere and one hundred and ninety-eight in the southern hemisphere. Thus the distribution by hemispheres is practically equal.

It is obviously unsafe to generalize on the distribution of the variables in space, seeing how rapidly their number is increasing. Anyone who examines the new catalogue cannot fail to observe how many stars there are whose periods are not yet determined, and consequently what a large field of work is here open to the industrious observer, especially in the southern sky. The amount of labour spent in compiling this epoch-making catalogue must have been enormous, considering how observations of variables are scattered over the scientific periodicals of different countries, and it is clearly far and away ahead in fulness and accuracy of anything of the sort previously produced.

I may now state the small errors which have crept into the article in the August Number. Class II. should be two hundred and thirty-nine; Class III., thirty-one; Class V., fifteen, instead of the numbers there given. The tables of analysis of II. and IV. are quite correct, but it was omitted to be stated that a large number of stars had no period assigned, and consequently could not be analyzed. In the article such doubtful stars were included in the enumeration in Class II., or long period, as it is most reasonable to suppose they will—most of them at least—turn out to have long periods of variation. A short-period star will reveal its variation quicker than a long one. The same remark applies to the Third Catalogue.

It is a great question whether it is possible to bind down some of these long-period stars by mathematical formulæ. Surely the maximum of such a star is a phenomenon intimately connected with chemical changes, the behaviour of gases under conditions unknown to us, and with electrical forces. Have we any formula to enable us to predict a sunspot maximum? *When* we have, then we may have some hope about a changing star; but at present it cannot be treated in the same way as we would the perihelion passage of a comet, where the laws and conditions are definitely known and can be applied in the study. As Mr. Flanery says, Mira, the most interesting star of the class, is as great a mystery as ever.

E. E. MARKWICK, Lieut.-Col.

Gibraltar, October, 1896.

MIRA CETI.

To the Editors of KNOWLEDGE.

SIRS,—A maximum of Mira *o* Ceti was due, according to Chandler's "Second Catalogue," and the "Companion," on November 3rd, the night before last; but the star had not quite reached 7·5 magnitude. My search for Mira this season began September 1st, but not until September 28th was a sight of it obtained. It was seen definitely then at or near ninth magnitude, an unusually clear night. Two or three views of it were obtained on as many nights following, but it was then lost and not seen again. Moon large and clouds interfering till October 28th and 29th, when it was about 7·8 magnitude. November 2nd it was 7·6 magnitude. R Leonis is also on the rise, visible in the early morning. It was 7·3 magnitude this morning. Its maximum is due in December.

Memphis, Tenn., DAVID FLANERY.
5th November, 1896.

LUNAR RAINBOW.

To the Editors of KNOWLEDGE.

SIRS,—On the night of the 25th October, at 9.35 P.M., I was fortunate enough to observe a third fine lunar rainbow. The bow was this time quite complete, and about one-third of the circumference of the circle long. It shone with a silvery white light, but showed traces of colour, especially green, at its extremities. It gradually faded away, beginning at the middle; and at 9.43 it had completely disappeared. It is remarkable how many lunar rainbows have been seen during the last few months.

Exmouth. J. M. WADMORE.

THE THEORY OF THE TIDES.

To the Editors of KNOWLEDGE.

SIRS,—I trust that Mr. Cornish will acquit me of any desire to gain an academic victory. My sole desire is to elicit and to spread a tolerably accurate knowledge of a very abstruse subject. I do not for a moment doubt that he has a knowledge of all that is known on the subject; but I think that anyone reading his original words would receive the impression that the "second" tide is caused by the moon drawing the earth from under the water, which is just the old stock fallacy of popular tidal literature. I might apply a similar remark to Sir R. Ball, whose "Time and Tide" is so often quoted by amateur disputants.

Mr. Cookson's letter, which appeared in the August Number, raises an ingenious and, as far as I know, a novel speculation. It would seem very natural to suppose that the huge barrier wall of the west coast of the Americas must *reflect* the tidal wave impinging against it; but how far it actually does so, and, still more, whether this is in any degree responsible for the "second tide," is a question which I at least cannot answer.

The study of the "establishment of the port," as derived from practical observation, is a very complicated affair indeed.

We know that where there is an irregular coast-line there may be two ports, relatively near to each other, at one of which the "primary" tide may be almost simultaneous with the "secondary" tide at the other. But, as far as I am aware, all ports that have any tide have two tides each day, nearly equal in height, and pretty accurately twelve hours apart.

Let us consider the case of the Galapagos Islands, which lie some eight hundred miles off the west coast of Ecuador, and roughly ten thousand miles from the east coast of Asia. Now, if Mr. Cookson's speculations are accurate, the "secondary" tide (rebounding from the west coast of Ecuador) ought to occur only about an hour later than the "primary" tide which has followed the moon from the coast of Asia. But is this the case? Will someone who has a comprehensive list of tide tables answer this question?

I am glad that this fascinating problem is interesting so many readers. May I, in conclusion, draw their attention to a small book on the "Elementary Theory of the Tides," by Prof. Abbott? This is the only book I have met with that gives an accurate idea of what is known about the tides, expressed in terms that are intelligible to anyone who possesses a knowledge of elementary mathematics. I am of opinion that no one (apart from trained mathematicians) who has not read this book can be in a position to grasp the theory of tide production. It does not claim to be original, but is a simplified extract from Sir George Airy's treatise. C. ROBINSON.

August 1st.

THERIDION LINEATUM AND NOTES ON SPIDERS.

To the Editors of KNOWLEDGE.

SIRS,—With reference to the Rev. S. Barber's letter and article appearing in KNOWLEDGE for September and October, if the Rev. S. Barber has any doubt about "a new

variety" of *T. lineatum*, I would advise him to send it to the Rev. O. Pickard-Cambridge, Bloxworth Rectory, Wareham.

From the account of the shooting lines, etc., I should imagine Elmsett to be a *very* wonderful place for spiders, though I much doubt if anyone could rise from his seat, go to the window, etc., without creating enough draught to float a spider's thread.

The second "marvellous illustration" loses all its charm from the fact that there are so many draughts about a dinner party, which might account for the strange lines being seen. A SPIDERMAN.

RUNES AND OGHAMS.

To the Editors of KNOWLEDGE.

SIRS,—In the October Number of KNOWLEDGE, page 233, I notice that "runes" were found on the Potomac River. I happened to be in Washington when this hoax was started in a local paper, probably as an advertisement for a storekeeper in whose window the copy of the alleged inscription was exhibited. The thing was so palpably absurd that few were deceived. The translation, no doubt, was perfect. This happened nearly thirty years ago, and is a specimen of the survival of the unfittest.

Washington, D.C., U.S.A. CHAS. A. SCHOTT.
October 18th, 1896.

On page 251 of KNOWLEDGE for November, Prof. Auwers' name was, by a printer's error, spelt "Amvers."

Notices of Books.

Applied Magnetism. An Introduction to the Design of Electromagnetic Apparatus. By J. A. Kingdon, B.A. (Alabaster, Gatehouse, & Co.) Illustrated. 7s. 6d. In mathematical works it has been usual to discuss the phenomena and laws of magnetism from the point of view of a unit magnetic pole. But a magnet has two poles, and the result of building upon the idea of the work done by or upon isolated poles is a mass of theory of little practical value. A simpler and much more satisfactory way to treat the subject is to consider a magnet as a conductor of a flow or flux of magnetism, and thus analogous to an electric conductor. The force or agency—it may be an electric current or a permanent magnet—which sets up magnetic flux is called the magnetomotive force, and is similar to electromotive force, while the magnetic current or total magnetic flux is found by dividing the magnetomotive force by the magnetic resistance, or reluctance, as it is called. The work before us is distinguished by the fact that this magnetic resistance method of dealing with magnetism is followed. The result is a clear and simple description of modern ideas of magnetism applied to the design of dynamos and other electromagnetic apparatus. In sixteen chapters the author deals with the general principles of magnetism, electromagnetic units, magnetomotive force, magnetic traction, generation of electromotive force, qualitative magnetism, the alternator, the dynamo, magnets and magnetic leakage, commutators and collectors, hysteresis, alternating magnetic flux, electromotors, polyphase currents and rotary fields, and magnetic measurements.

The nomenclature of magnetic units is still in a somewhat undefined condition, but the difference of opinion that exists as to the names to be given to practical magnetic units does not, of course, affect the character of Mr. Kingdon's work, which is excellent in text and arrangement, and will serve to give students of electrical engineering exact ideas on the science of magnetism without the use of higher mathematics.

The Wonders of Modern Mechanism. By C. H. Cochrane. (Illinois: Lippincott.) The author has given in this book wonderfully clear and simple explanations of a great many inventions and mechanical appliances. It is essentially a popular account of the wonders of modern mechanism, and the author has been eminently successful in imparting a great deal of knowledge in simple terms. In order to show the scope of the book, we may mention that it treats of the following, amongst a large number of subjects:—Bridges, electricity, ships, horseless vehicles, mining and many other kinds of machinery, printing, and other industries. It will be read with the greatest interest by everyone, and will prove useful as a book of reference, although a complete index would have made it much more valuable in this respect.

BOOKS RECEIVED.

Worms, Rotifers, and Polyzoa. By F. W. Gamble, M.Sc.; Miss L. Sheldon; A. E. Shipley, M.A.; and Others. (Macmillan.) Illustrated. 17s.

Prehistoric Man and Beast. By Rev. H. N. Hutchinson, B.A., F.G.S. (Smith, Elder.) Illustrated. 10s. 6d.

Habit and Instinct. By C. Lloyd Morgan, F.G.S. (Arnold.) Illustrated. 16s.

The Clue to the Ages. By E. J. Page. (Baptist Tract and Book Society.)

Autobiography of Sir George B. Airy, K.C.B., M.A., LL.D., F.R.S. Edited by Wilfrid Airy, B.A. (Cambridge University Press.) 12s.

Life in Ponds and Streams. By W. Furneaux, F.R.G.S. (Longmans.) Illustrated. 12s. 6d.

Round the Year. By Prof. L. C. Miall, F.R.S. (Macmillan.) Illustrated. 5s.

Joseph Thomson, African Explorer. By his Brother. (Sampson Low.) Illustrated.

Alternating Currents. By D. C. and J. P. Jackson. (Macmillan.) Illustrated. 14s.

Higher Mathematics. By Mansfield Merriman and R. S. Woodward. (New York: Wiley. London: Chapman & Hall.) 21s.

The Gases of the Atmosphere. By William Ramsay, F.R.S. (Macmillan.) Illustrated. 6s.

Structural Botany. Part II.—Flowerless Plants. By D. H. Scott, M.A., F.R.S. (A. & C. Black.) Illustrated. 3s. 6d.

The Elements of Physics. Vol. II.—Electricity and Magnetism. By E. L. Nichols and W. S. Franklin. (Macmillan.) Illustrated. 6s.

Fuel and Refractory Materials. By A. H. Sexton, F.I.C. (Blackie.) Illustrated. 5s.

Bell's Reader's Shakespeare. Vol. II.—The Tragedies. (Hodder.) 3s. 6d.

The Model Locomotive Engineer. By Michael Reynolds. New Edition. (Crosby Lockwood.) Illustrated. 3s. 6d.

Elementary Decoration. By J. W. Facey. Third Edition. (Crosby Lockwood.) Illustrated. 2s.

Induction Coils and Coil-Making. By F. C. Allsop. (Spon.) Illustrated.

Problems of Biology. By George Sandeman, M.A. (Swan Sonnenschein.)

The Literature of Music. By J. E. Matthew. (Elliot Stock.)

A New Course of Experimental Chemistry. By J. Castell-Evans, F.I.C. (Thomas Murby.) 2s. 6d.

Physiography for Beginners. By A. T. Simmons, B.Sc. (Macmillan.) Illustrated. 2s. 6d.

British Patent Law. By H. Hals. (Whittingham.) 1s. 4d.

Physics Note Book, with Spaces for the Pupil's Drawings of Experiments. (Macmillan.) 2s. 6d.

SHORT NOTICES.

The Report of the City and Guilds of London Institute for 1895-6. In this report of the work of the London Institute on behalf of "the advancement of technical education," one cannot but feel pained that the artizans fail to realize the benefits provided for them by this department. We find that only twenty-nine thousand four hundred and ninety-four students attended these classes last year, out of the multitudes of young workers who require technical training. A second difficulty is experienced in finding competent teachers for these trade classes, and it seems to be generally admitted that the best instructors have yet to be found, as witness many of the reports of the examiners at the end of this report.

William Wesley & Sons send us their useful catalogue (No. 126, 1896) on invertebrate zoology. All those who desire to study the

biology and morphology of the invertebrates would do well to send for a copy of this catalogue of scientific books and monographs.

In the *Quarterly International Journal of Microscopy and Natural Science* (October, 1896) is to be found a short paper upon "The British Hydrachnidæ"—Genus VI., Diplodontus—by Charles D. Soar. The drawings are very good, but the descriptions are very meagre considering the literature which has been published upon the genus by various microscopical societies.

In the *Observer* (Portland, Conn.) for September there are several very interesting articles; one, on "First Steps in the Study of Fishes," by Dr. R. W. Shufeldt (Washington), is illustrated by a plate giving twenty-three types of fins and forms of fishes. It is full of suggestion to the young ichthyologist. Those who are desirous of studying the habits of the trapdoor spiders will find an article on "The Ctenzia Californica," by F. E. Gray, who is evidently a practical observer.

The Journal of Physical Chemistry (October, 1896). Edited by Wilder D. Bancroft and Joseph E. Trevor, of Cornell University. This is the first number of what promises to be an important addition to chemical literature when the magazine is settled into working order. There are three highly technical articles in this number—one, on irreversible cells, by A. E. Taylor, giving ten tables of valuations of the electromotive forces of the cells in the various chemical solutions described in the text; the second article is a translation of Prof. F. Wald's (Austria) manuscript on "Chemistry and its Laws"; and a paper on "Ternary Mixtures" by W. D. Bancroft.

Those interested in the rise and progress of mining cities will find an illustrated paper on "Nevada Silver," by Charles H. Shinn, in the October number of *Appleton's Popular Science Monthly*. It describes the finding of the gold and silver, and how "Old Pancake" (H. T. P. Comstock) "bluffed the good-natured discoverers into taking himself and Manny Penrod as equal partners." The history of the men who discovered the mines first is graphically described. The lawsuits cost one-fifth of the products of the mines (five million dollars) during 1860 to 1865. The pitched battles, forts, and the armed men drilling, all find a place in the history of this famous corner of Utah.

A POSSIBLE CAUSE OF CHANGE ON THE MOON'S SURFACE.

By Charles Davison, Sc.D., F.G.S.

In spite of the fruitless search of many years, astronomers have not yet apparently given up hope of discovering changes on the moon's surface. And the hope does not seem to be altogether without foundation. In the great changes of temperature which take place on the moon, changes which are untempered by any atmosphere such as we possess, there resides a cause capable perhaps of producing effects that may in time become perceptible to our telescopes.

The suggestion that such may be the case is due, I believe, to Messrs. Nasmyth and Carpenter. During the long lunar day, they remark, the surface attains a temperature of about 500° F., and during the equally long lunar night one of about - 250° F. "Such a severe range of heat can hardly be without effect upon some of the component materials of the lunar surface. If there be any such materials as the vitreous lavas that are found about our volcanoes—such as obsidian, for instance—they are doubtless cracked and splintered by these extreme transitions of temperature; and this comparatively rapid succession of changes continued through long ages would, we may suppose, result in a disintegration of some parts of the surface, and at length somewhat modify the selenographic contour." On the other hand, "it is possible," they add, "that the surface matter is mainly composed of more crystalline and porous lavas, and these might withstand the fierce extremes like the 'fire-brick' of mundane manufacture, to which in molecular structure they may be considered comparable. Lavas as a rule are (upon the earth) of this unvitreous nature, and if they are of like constitution on the moon, there will be little reason to suspect changes from the cause we are considering." They think it conceivable, however, "that the alleged changes in the crater Linné may have been caused by a filling of the crater by some such crumbling action as we are here contemplating."*

In making this suggestion, Nasmyth and Carpenter are appealing to no imaginary agency. Several instances might be given of the splintering of terrestrial rocks by more or less sudden cooling. It will be sufficient to mention one case, observed by Livingstone in the valley of the Gova, a river flowing into Lake Nyassa. "Several of the mountain-sides in this country," he says, "are remarkably steep, and the loose blocks on them sharp and angular, without a trace of weathering. For a time we considered the angularity of the loose fragments as evidence that the continent was of comparatively recent formation, but we afterwards found the operation actually going on by which the boulders are split into these sharp fragments. The rocks are heated by the torrid sun during the day to such an extent that one is sometimes startled on sitting down on them after dusk to find them quite too hot for the flesh, protected by only thin trousers, to bear. The thermometer placed on them rises to 137° in the sun. These heated surfaces, cooling from without by the evening air, contract more externally than within, and the unyielding interior forces off the outer parts to a distance of one or two feet. Let anyone in a rocky place observe the fragments that have been thus shot off, and he will find in the vicinity pieces from a few ounces to one or two hundred pounds in weight, which exactly fit the new surface of the original block; and he may hear in the evenings among the hills, where sound travels readily, the ringing echo of the report, which the natives ascribe to Mchesi or evil spirits, and the more enlightened to these natural causes."†

If changes of temperature can produce such effects on the earth, they must act still more powerfully on the moon. There, especially on the mountain-sides, large areas are *suddenly* exposed to, or withdrawn from, the action of the sun's rays. Moreover, the range of temperature, as we have seen, is enormously greater. Thus, if the rocks which compose the lunar mountains resemble even approximately those which are found upon the earth, there must evidently be much fracturing and splintering; level or inclined surfaces must in places be covered with loose fragments of rock, while against the steeper hillsides slopes of loose rocks, or "screes," must be piled up.

It appears to me that these screes, if they exist and are perceptible, are the regions where signs of change should be especially looked for. As fresh fragments fall down from the crags above, the slopes of the screes increase until they attain, or nearly attain, their maximum inclination. The surface blocks are then in a highly unstable condition, and every newly-fallen rock showers down numbers of others all round it before it finally comes to rest.

Thus, if screes are found at all upon the moon, they will continually increase in size until they mask the parent cliff. So far as we know, there is little to check their rate of growth, except that growth itself, which gradually lessens the area from which new blocks are to be derived. The blocks themselves may splinter still further until the spaces between them are filled up with small fragments and dust, and this may perhaps retard their movement; but there can be no vegetation to find a root in this soil and so bind the surface stones together.

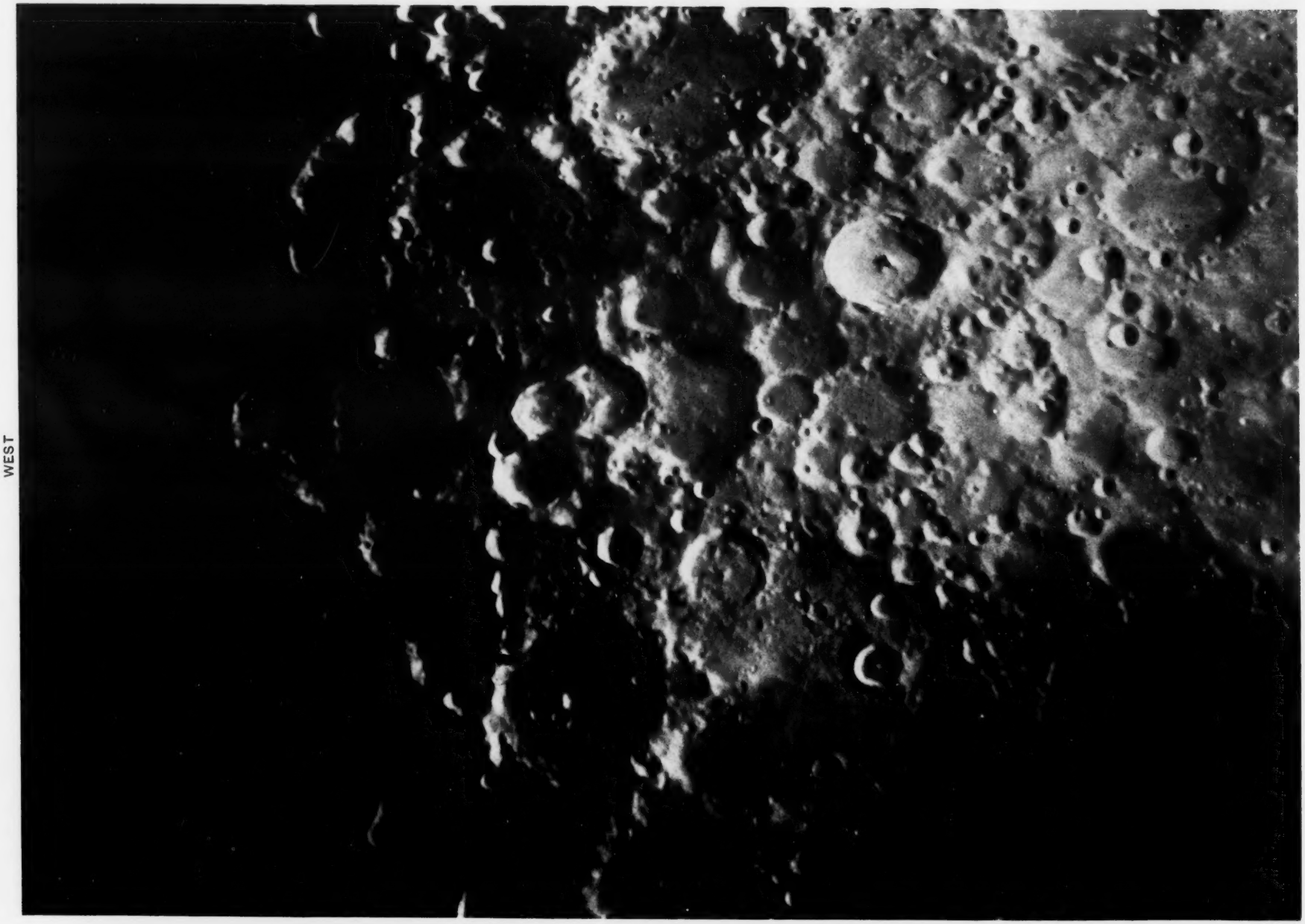
While changes of temperature furnish the materials of screes, and gravity rearranges them, these two agencies in concert are capable of producing a further movement of

* "The Moon: considered as a Planet, a World, and a Satellite," 1885, pp 172-174.

† "The Zambesi and its Tributaries," pp. 492, 493.

XUM

SOUTH.



WEST

EAST.

NORTH.

THE LUNAR METROPOLIS.

From a Photograph taken at the Lick Observatory, Mount Hamilton, California, 1895, October, 9d. 16h. 36m. 15s.–25s. Pacific Standard Time, with the 36-inch Refractor, and Brashear Enlarging Lens. Age of Moon, 21d. 15½h. Scale, 44 inches to the Moon's Diameter.

the blocks, to which it is my principal object in this paper to draw attention.

A little more than forty years ago, part of the lead on the roof of Bristol Cathedral was found to have crept slowly downwards, the total descent being about a foot and a half in two years. Soon afterwards the now well-known explanation of the movement was given by Canon Moseley. When the lead is heated it expands, but it is easier to move down the slope than up it; so that, while some of the lead at the top of the sheet moves upwards, a far larger part moves down. When the lead is cooled it contracts; part near the lower edge moves up the slope, but a far larger upper portion moves downwards. Thus, on the whole, with every change of temperature to and fro, the whole sheet of lead makes a short creep down the slope.

In this case, since the sheet lead is thin, the movement is principally due to the fact that the lead and wooden surface on which it rests have unequal coefficients of expansion. If they had been of the same material the creep would have been almost imperceptible. When, however, one stone rests upon another of the same kind, the two are unequally heated on account of the small conductivity of rock, and the ultimate result is the same.

A few years ago I made some experiments on the creeping of stones arising from changes of temperature.* In the first, one brick was placed on another inclined to the horizon at an angle of twenty degrees. On the upper edge of the upper brick, and on another independent brick support, a level was placed with the bubble in the centre of the tube. The level was read frequently, and it was found that while the upper end rose slightly during the day, it descended by a greater amount during the night, so that at the same time each day it stood at a lower level. This experiment showed that the stone did creep in the manner supposed by Moseley, though it gave no idea of the extent of the movement, as the angular value of the scale-divisions of the level was undetermined.

The object of a second experiment was to ascertain how far a stone would creep in a year under given conditions. I had two slabs of York stone cut, each three feet long, five inches wide, and two inches thick. One face and one side of each stone were smoothed, and the stones were placed with their smoothed surfaces in contact, and inclined at an angle of seventeen degrees to the horizon. The smoothed sides of the two stones were continuous and three fine scratches were made on them, in the middle and at each end, so as to be at starting in the same straight lines. At the end of a week the displacement of the upper stone, though exceedingly slight, was quite perceptible, and it continued so throughout the year, the total creep in this interval being thirteen and one-sixth millimètres, or a little over half an inch.

So small a movement may be considered hardly worth taking into account. But it must be remembered that it affects every stone free to move and resting on an inclined surface. Moreover, the creep is proportional to the length of the stone and to the range of temperature to which it is subjected, and the length of the lunar compared with that of the terrestrial night, is probably more than counterbalanced by the magnitude of this range.

If changes in the manner here described do take place upon the moon, it is evident that they must be exceedingly gradual. Years must elapse before they become perceptible to us; but as the changes would take place always in one direction, it seems not impossible that a careful scrutiny of a few selected districts would in time reveal their existence.

* "Note on the Movement of Scree Material," *Quart. Journ. Geol. Soc.*, 1888, pp. 232-237, 825, 826.

THE LUNAR METROPOLIS.

By E. WALTER MAUNDER, F.R.A.S.

THE lunar photograph we give this month is from the same negative as that which appeared in the October Number of KNOWLEDGE, and forms a continuation of it; indeed, it overlaps it to a small extent. It likewise slightly overlaps at the terminator the photograph given in our April Number of Cuvier and Licetus. The general characteristics of the district are the same as around Clavius. If anything, the complexity of detail and the intricacy of overlapping formations is greater in the region now presented than in the one shown in October.

The interest of the district centres in Tycho, not on account of its size, though this is very considerable, as it is over fifty-four miles in diameter—almost as large as Copernicus; but whereas Copernicus is so placed as to have attention drawn to it, Tycho is dwarfed by many of the neighbouring objects, such as Clavius, Longomontanus, and Maginus, shown in our October photograph, and the extraordinary complexity of the region surrounding it takes off the due effect of its proportions.

It is important, however, as being in the very centre of the most disturbed region of the moon—a land of the wildest and most rugged character, and sown so thickly with crater pits and bowl-like depressions that it is hard to refrain from adopting the hypothesis of some theorists, that the moon, when in a plastic state, has been subjected to a fierce bombardment by great meteorites, who have left the tokens of their assault in these thickly clustered scars upon its surface.

The great claim, however, of Tycho to distinction—the circumstance which has won for it the apt title of the "Lunar Metropolis"—is the streak system which radiates from it in all directions. This system—the most striking feature of the moon at full—is, of course, not visible in our present photograph, which shows the moon at her third

quarter. On the photograph, therefore, the broad and lofty rampart, deep floor, and bold central peak of Tycho are the features that most distinguish it.

The other walled and ringed plains shown in our photograph are far too numerous to describe in detail, and, indeed, the photograph itself will yield more information than could be given by much writing. Longomontanus

THE LUNAR METROPOLIS.
From a Photograph taken at the Lick Observatory, Mount Hamilton, California, 1895, October, 9d. 16h. 36m. 15s.-25s. Pacific Standard Time, with the 36-inch Refractor, and Brashear Enlarging Lens. Age of Moon, 21d. 15·5h. Scale, 44 inches to the Moon's Diameter.

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and Maginus, of the October plate, are seen in this—the first, partly; the second, wholly. Heinsius, to the east of Tycho, is very easily identified from the remarkable way in which three great parasite ring plains have invaded and destroyed its southern wall. On the opposite side of Tycho is Pictet, a walled plain as irregular as Heinsius is regular; beyond it, the regular ringed plain, Saussure. West of Saussure, the photograph shows beautifully a mountain range which makes on this side, as it were, a second rampart to the plain. Three ringed plains follow to the north. In the last of these, Miller, the central mountain, which almost exactly marks the prime meridian of the moon, still just rises above the shadow of the eastern wall. Further north is Walter, the largest walled plain of the district, one hundred miles in diameter. The region to the east contains several very regular objects: Lexell, a regular walled plain; Ball and Hell, two ringed plains with five central mountains, well shown in the photograph. Walter, Lexell, Ball, and Regiomontanus, the latter an irregular walled plain on the edge of the photograph, border a considerable area less broken than most of this district. In this more open country Hell is the principal formation.

East of Hell is Pitatus, a great walled plain, which, with its companion Hesiodus, end in this direction the highlands of Tycho. Beyond them, to the north, lies the great grey plain, the Mare Nubium, the waters of which—if, indeed, it ever contained water—seem to have eroded part of the northern wall of Pitatus, and to have lowered that of its companion.

The terminator is occupied, proceeding from the south to the north, by Licetus, Faraday and Stofler, and Aliacensis, the great wall of which shines out in a fine arch at the foot of the plate.

Science Notes.

It has been recently discovered that iodine exists in combination in the human body. It occurs in the thyroid gland, and may be concerned as the essential chemical substance in the internal secretion of the gland. The proof of the occurrence of iodine in the living structures of animals is of great scientific interest and importance, and is the most remarkable discovery made by chemical physiology for some time.

The annual production of gold from all the various sources is at present about £42,000,000. This is twice the amount produced seven years ago. It is greater than at any previous period in the history of the world, the next greatest annual output being that of the year 1853, when the river gravels of California and Australia were in their most productive state. The amount extracted in the year was then estimated at £38,000,000. More than half of the total yearly amount is now got by the amalgamation process from crushed vein stuff.

Through the courtesy of Messrs. Beck, we have been able to examine and practically test their new Frena Camera of the memorandum size. This is an excellent little instrument, and is capable of producing good work. It is simple and effective in mechanism, and should prove very useful to amateurs, especially as its price is a popular one. The serrated edges of the celluloid films are a disadvantage, as on this account a considerable portion of the picture is lost. On the other hand, by this means the process of changing the films is greatly simplified.

An X-ray tube has lately been brought out by Messrs. Watson with greatly increased distance between the terminal attachments outside, and having also a palladium ring as anode placed above a platinum anticathode, the principle of which is that, when warmed, this palladium ring gives up some of its occluded hydrogen. In this way, when the vacuum gets too high it is possible to bring it down again at will. We have had one of these tubes in daily use for the last fortnight, a ten-inch spark coil being used. The vacuum has not perceptibly altered, and we have not, as yet, had occasion to warm it. It can only be supposed that the palladium ring has given up some hydrogen without warming. The results attained with a screen are particularly good. But in case warming should be necessary, the tube, as now arranged, would have to be disconnected to carry this out. To avoid this it might be suggested that the ring might be done away with, and instead that a small bulb be attached to the exhaust tube containing a *small* quantity of spongy palladium (which occludes about two hundred times its volume of hydrogen). The vacuum could then be adjusted while the tube was in action.

Investigations have been made by different observers to determine whether the Röntgen rays are homogeneous or not. The methods employed consisted in testing whether substances placed in the path of the rays exhibited selective absorption, and distinct indications of this were found, showing that Röntgen rays are not all of one kind, but that the effects are produced by radiations of different wave-length. Dr. Famm, by means of diffraction experiments, has found that the greatest wave-length of the Röntgen radiation is about one-fifteenth that of the shortest ultra-violet waves hitherto measured. Herr Arnold finds that the Röntgen rays can be applied to detect adulteration in various articles of food; the foreign substances added frequently greatly altering the transparency of the article tested, and thus changing the character of the shadow picture thrown on a fluorescent screen.

In France, where so much has been done by M. Moissan in the way of the production of small artificial diamonds by means of his electric furnace, a recent observer, M. Rossel, has detected the presence of small diamonds in certain specimens of hard steel. By suitable treatment, insoluble fragments were got from the steel which possessed all the properties of natural diamonds. M. Moissan's method of preparing artificial diamonds consists in saturating iron with carbon at a high temperature in the electric furnace, and cooling the fused metal under a high pressure. The carbon present thus assumes the crystalline form of diamond. In M. Rossel's specimens the steel had been subjected to a similar treatment in the course of its manufacture, and the diamond crystals were produced from the carbon always present in steel and cast-iron.

The most ancient copper mines in the world are those of the Sinai peninsula, near the Gulf of Suez. M. Berthelot gave an account of them to the French Academy of Sciences in August. They were abandoned about three thousand years ago, after having been worked for some hundreds of years. The process used for the reduction of the ore was similar in principle to that used at the present day.

In the recent researches on light and ethereal vibrations of all sorts, the interesting fact has been discovered that the light emitted by glow-worms is able to penetrate blackened paper, and affects a sensitive photographic plate placed underneath.

Messrs. Newton & Co. have just issued a new list of some very useful series of lantern slides. Amongst others may be noticed the series on astronomy taken from photographs which have appeared in Knowledge, a series on British birds' nests, and another on the X-ray photography.

WAVES.—XII.

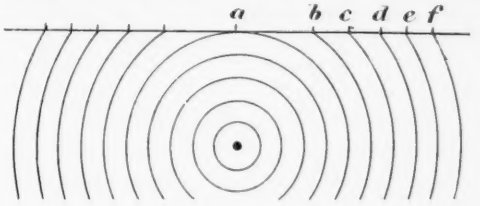
EARTHQUAKES, THE PULSE, NERVE WAVES, AND TELEPATHY.

By VAUGHAN CORNISH, M.Sc.

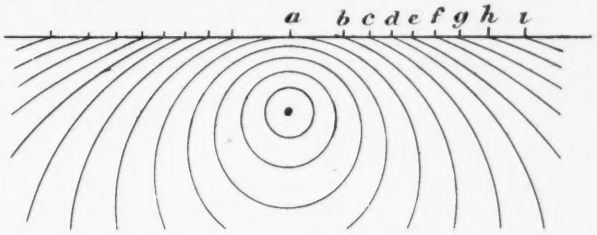
THE earth trembles with the shock of displacements which occur from time to time in those superficial parts which are termed the earth's crust. These displacements are the bending, crumpling, cracking, or slipping of the rocks, and, occasionally, volcanic outbursts or upheavals. The most general description of the original disturbance is a wrench: that is to say, a single movement which may be analysed into two components, a pull and a twist, or a shear. Most earthquakes originate at a depth which is rather great compared with the depths of mines, but very small compared with the diameter of the earth. The vibration which they produce at the surface is generally that corresponding to a wrench. The movement which goes on between the origin and the surface is probably, as in other cases of transmission by waves, different from the disturbances where the wave is set up, and where it ends. A wrench both compresses and distorts the rock, and two waves appear to be set up—a wave of compression and a wave of distortion—which travel with different velocities. The elasticity of volume of the rock—the force with which it tends to recover elastically from compression—enables the solid earth to transmit a wave of longitudinal displacement, which is similar in character to the sound-producing waves which are elastically transmitted in fluids. The rigidity of rock, the force with which it elastically recovers its shape after distortion, enables the solid earth to transmit a wave of transverse displacement, which may be compared to the light-producing waves transmitted by the ether. When these two waves break simultaneously at the earth's surface, the shock (as has been said) may resemble the complex disturbance which originated the waves; but if one wave travel quicker than the other, the character of the surface disturbance at its commencement may be simpler. In practice it is found that when the origin of the earthquake is at a great distance the preliminary tremors precede the main shock by a considerable interval, which indicates that some part of the disturbance travels more quickly than the rest.

The interval which elapses between a shock at the surface near the origin and its arrival at a point near the antipodes is often so short that, according to Prof. Milne, the wave cannot have had time to travel round the earth by transmission through the superficial layers of rock, having regard to the rate at which these are known to transmit wave motion. It appears, therefore, that the seismic wave can be transmitted right through the earth. Delicate seismographs show an almost continual trembling and quivering of the earth's surface, the tremors at any point being generally due to local causes, but occasionally caused by distant shocks. The surface of the earth, being the boundary of the transmitting medium, experiences a maximum amount of disturbance. The familiar experiment with a row of glass marbles illustrates this point. If a shock be given at one end of the row, it is the marble at the opposite end of the row which moves most, the intermediate marbles transmitting the shock but moving scarcely at all. At the boundary of the transmitting medium a wave *breaks*, and the energy takes on a new and violent form. Thus is the shore battered by the sea, and thus is the earth heated by the breaking of the ether waves sent to us by the sun.

The "speed of an earthquake," like the speed of electricity, is a term which may have several different meanings. The most important speed from a practical point of view is the quickness with which the shock reaches successive points throughout a country exposed to the visitation. This is a variable velocity which depends not only upon the speed of the earthquake wave, but also upon the position of the origin. If the wave radiates in circles from the origin, and if the circles in Fig. 1 represent the wave front at successive minutes,



then the positions *a*, *b*, *c*, *d*, etc., are the points on the earth's surface where the shock is felt at the successive minutes. It is seen at a glance that the apparent surface speed of the earthquake is much greater nearly above the origin, and that at a distance it tends to reach a constant value which is nearly that of the true rate of the wave. If, however, as is probable, increase of pressure so much increases the elasticity of rock that the speed of the wave is greater at greater depths, the wave front will not be spherical, and the "rays" drawn from the origin at right angles to the wave front will not be straight lines, but will be curved towards the surface, as Dr. A. Schmidt has pointed out.* The effect upon the surface speed is shown in Fig. 2; it first diminishes rather rapidly until it reaches a velocity equal to that of the wave at the origin, but afterwards increases gradually. The progressive visitation of the localities *a*, *b*, *c*, *d*, etc., as shown in these figures, is not the travel of a surface wave but the



arrival of an obliquely-moving breaker. The disturbance of level which is produced by the breaking earth-waves does, however, set up a true surface wave, the ground undulating much as the surface of water will undulate if a submarine mine be exploded. The surface earth wave is said to be a gravitation wave: that is to say, one which travels by the attraction which subsists between the disturbed parts and the remainder of the globe. The amplitude of the surface earth wave is very small. Seismic sea waves, on the contrary, are often of terrific height. In these the surface wave is often due more to ruptural displacement of the sea bottom than to mere oscillatory movement. The great sea waves which traversed the southern oceans during the convulsions at Krakatoa were presumably due to such displacement.

* * * * *

The pulse is produced by a peculiar wave which demands

* See *Nature*, October 24th, 1895.

a brief mention in this concluding article. To fix our ideas we will suppose that we are dealing with the familiar artery which gives the pulse of the wrist. At each beat of the heart, blood is pumped into the near end of the artery and the valve is quickly shut. Very quickly afterwards an extra quantity of blood is forced from the artery into the veins and capillaries. This is not the particular dose of fluid which has just entered the artery, but a discharge from the other end of the stream, where a pulse is felt almost immediately after the throb of the heart. The push, or impulse, is transmitted from point to point along the artery, not as hydrostatic pressure is transmitted by an incompressible fluid, but after the manner of a wave. For the blood is not enclosed in a rigid pipe, but in a flexible tube, so that, although the fluid does not yield to pressure, the tube does, and the end nearest the heart expands to accommodate the extra dose of fluid. Expansion of the tube is, however, followed by contraction, for the tube is elastic though yielding. The next portion of the tube then expands, and so on, a billow travelling down the artery. When the billow reaches the wrist it can be both seen and

FIG. 3.—Pulse Tracing of Diseased Heart.

felt. It has passed the wrist before the next dose of fluid is delivered from the heart, so that only one billow is ever traversing the artery. The profile of the billow is recorded in an exaggerated manner upon the well-known pulse tracings. These provide a permanent record of the condition of a patient's pulse which is convenient for reference. Each of the pulse tracings shown in Figs. 3 and 4 records a number of beats; the wave is travelling to the right; from trough to trough is a complete pulsation.

* * * * *

The brain is kept in touch with the external world by some kind of wave motion, the mechanism by which the sensory nerves transmit their message. The velocity of the wave, which is always considerable, varies to some extent in different people, as one would naturally expect. Responding to the wave of feeling, transmitted by the sensory nerves, is the wave of will, whereby the motor nerves transmit to the muscles the message of the brain.

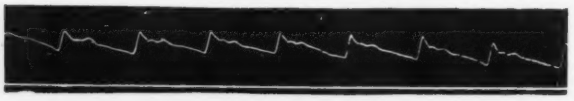


FIG. 4.—Pulse Tracing of Fairly Normal Heart.

Whether mind can act upon mind, otherwise than by means of the ordinary senses, is a much debated question. Some aspects of this question of telepathy come within the proper scope of physical science. It comes within the province of physical science, for instance, to inquire into the possible extra-sensual means of action of one brain upon another. Space is filled with a medium, known to science, which has a wonderful power of transmitting very various disturbances without loss and with great swiftness, and one would naturally inquire first whether the known modes of motion of ether are such as might account for telepathic phenomena, on the supposition that the active brain is capable of disturbing the ether. Now one of the most remarkable points about the narratives of, say, phantasms of the dying, is that the intensity of the recorded impressions scarcely diminishes with distance, even though the distances vary from one mile to eight thousand miles. Waves *radiating* from the brain will therefore not explain the recorded phenomena, for even if the motion be transmitted without loss, the expansion of the wave front would rapidly diminish the intensity. Nothing else than a motion or disturbance confined to a channel will do, as happens, for instance, in the disturbance and reproduction of disturbance between the sending and receiving parts of a telephone. These are connected by the telephonic wire. I am not aware that anything has been found corresponding to a telepathetic wire.

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THE BEECH.

By GEORGE PAXTON.

THE beech (*Fraxinus excelsior*) is a magnificent tree, which vies with the oak, in some respects, for the proud title, "King of the Forest." Although not "every inch a king," he may be styled a noble forest prince.

The beech is only a doubtful native of England, and is not indigenous to Scotland or Ireland, although now so common in these islands. It is found in forests in Central and Southern Europe, Asia, North and South America, and even in Australia. In Switzerland it occupies the south sides of the mountains, and it is the national tree of Denmark. In Britain it grows to a large size, occasionally attaining a height of one hundred and twenty feet, but is oftener seen from sixty to eighty feet, with a girth of twelve to sixteen feet. Fig. 1 represents a beech growing on the banks of the River Ayr. This tree has a girth of over eighteen feet at five feet from the ground, with a height of about ninety feet.

The leaves, which appear in the beginning of May, are shining, oval, veined underneath, and slightly notched

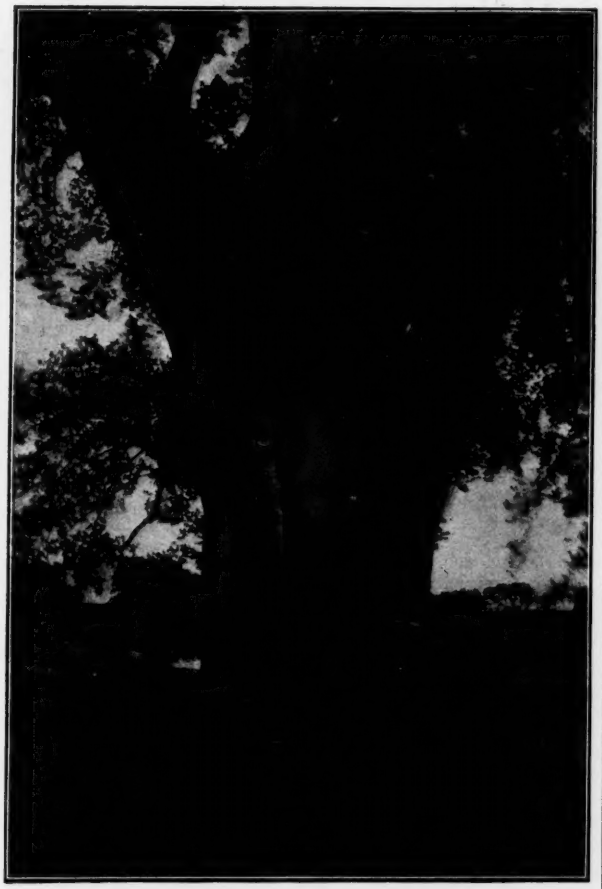


FIG. 1.—A Beech Tree growing on the Banks of the River Ayr.

(Fig. 2). In spring they are of a pale green tint, turning darker as they increase in size, and in autumn they assume a beautiful russet hue; then, as Dr. E. Lees so eloquently puts it, "the splendour of every other tree fades before that of the beech, which continues the longest of all, and under particular circumstances is of the most brilliant description. This arises from its lucid leaves, which vary in hue from auburn to gold colour and umber, reflecting back the level rays of the descending sun, and thus burning with a pre-eminent lustre, like a sudden illumination." The flowers appear soon after the leaves and take the form of globular clusters, the male on longer and more slender drooping stalks than the female. The fruit—the well-known brown nuts—are of a sharply triangular shape and enclosed in pairs in a prickly husk. They ripen in October; the husk, opening in four sections, allows the nut to drop out while it remains for a time attached to the tree.

The beautiful smooth olive-grey bark, although not glossy like that of the birch, gives the bole of the beech a peculiar charm of its own. This is best seen when strolling through a beech wood on a bright winter day; the pale fluted trunks, which stretch on all sides as far as the eye can reach, appear as if carved in stone, like the lofty columns of some grand cathedral, but infinitely more varied, while the sun lights up the stems and shows off their beauty. On these trunks may often be seen scattered excrescences, called "knurs," varying in size from a pea to a large marble; they may be knocked off by a sharp blow with a stick, and are found to be composed of a solid ball of wood, surrounded by a layer of bark. What causes these knobs does not seem to be well known; they are said to grow if planted, and are sometimes seen shooting while attached to the tree.

The wood of the beech is used for an immense variety of purposes. It is heavier when green than that of any other of our timber trees, but loses nearly one quarter of its total weight in drying; it is tolerably hard and somewhat brittle, close and even in texture, with a fine silky grain and not difficult to work. Although not very lasting when exposed to the air, if kept submerged it lasts well, and is therefore in use for keels and planking of boats, mill wheels, sluices, etc. Turners find it useful wood, as do cabinetmakers. As a fuel it is superior to the wood of most other trees, and from its charcoal gunpowder is manufactured. The branches and sprays are distilled for the production of pyroligneous acid.

FIG. 2.—Branch, Leaves, and Fruit of the Beech.

The "mast," once so valuable a source of rustic wealth, is still the favourite food of swine, deer, and poultry; and

in France large quantities of an excellent burning and cooking oil are made from the nuts.

Little or no vegetation will flourish under beech trees; the carpet of dried and decaying leaves and husks will be found much the same all the year round, seldom enlivened by anything green. This is the result of the dense shade, and the light, dry nature of the soil in which the tree delights, being drained yet more thoroughly by the closely matted roots spread near the surface. Two remarkable edible fungi, however, grow well under beech trees: these are the morel and the truffle. Both are much sought after in France and Germany, being highly prized for the table.

Several interesting varieties of the beech are in cultivation. The best known are the purple beech—originally discovered in a wood in Germany—the copper-coloured beech, and the fern-leaved beech, which has its leaves cut almost like a fern.

HELIUM AND PARHELIUM.

By E. Walter Maunder, F.R.A.S.

In the April Number of Knowledge an account was given of the very beautiful researches which led Profs. Runge and Paschen to the belief that the gas which Prof. Ramsay had extracted from clèveite was not a simple substance but a mixture of two distinct elements. The force of their conclusion may be better appreciated if we glance at the adjoining diagrams, wherein the spectrum of clèveite gas is analyzed in the same manner as the spectra of lithium and sodium were in the earlier paper.* In the first diagram the complete spectrum of the clèveite gas appears in the first line, except that double lines are shown throughout as single, the scale of the diagram not permitting the members of the doublets to be shown separately. The second line shows the complete spectrum of the parhelium constituent; the third, fourth, and fifth lines, its resolution into its three series; the sixth and three following lines show the complete spectrum of the helium constituent, and its similar resolution.

There is a point to which it was not possible to refer in the earlier paper and which should be noticed. Of the six rhythmical series of lines into which the clèveite gas was completely resolved, two approached one limit, two another, and were hence regarded as subordinate series. Of the other two—from their greater brightness and wider stride evidently principal series—one was taken as being associated with one pair of subordinate series, the other with the other. But in default of any known relation between principal and subordinate series, this association might have been as reasonably reversed. There is, however, an intimate relation which clearly marks out how in this instance the spectra are connected.

Referring to the April paper, we find that the limiting wave number of the principal series of lithium is 4351930, and the mean of its two subordinate series 2862672. The difference of these gives 1489258, very close to the wave number of the first line of the principal series. So with sodium: we have for the limit of the principal series 4149634, for the mean limit of the subordinate series 2452128, and for the first line of

* The formulæ employed by Profs. Runge and Paschen, *Astrophysical Journal*, January, 1896, for the six series of the clèveite gas are as follows:—

Helium:—

Principal ... $\frac{1}{\lambda} = 3845532{\cdot}4 - 1{\cdot}098919 \times \frac{10^7}{n^2} - 1{\cdot}4507 \times \frac{10^6}{n^3}$

Subordinate I. $\frac{1}{\lambda} = 2922435 - 1{\cdot}098363 \times \frac{10^7}{n^2} - 1{\cdot}67 \times \frac{10^4}{n^3}$

„ II. $\frac{1}{\lambda} = 2919796{\cdot}7 - 1{\cdot}061524 \times \frac{10^7}{n^2} - 8{\cdot}656 \times \frac{10^6}{n^3}$

Parhelium:—

Principal ... $\frac{1}{\lambda} = 3202986 - 1{\cdot}09537 \times \frac{10^7}{n^2} + 1{\cdot}9636 \times \frac{10^5}{n^3}$

Subordinate I. $\frac{1}{\lambda} = 2717516 - 1{\cdot}097587 \times \frac{10^7}{n^2} - 2{\cdot}726 \times \frac{10^4}{n^3}$

„ II. $\frac{1}{\lambda} = 2716859{\cdot}5 - 1{\cdot}088256 \times \frac{10^7}{n^2} - 3{\cdot}596 \times \frac{10^6}{n^3}$

It will be noticed that the third power of n is used instead of the fourth, as in the formula given on page 88. Probably the exact formula would contain an indefinite number of terms, with increasing powers of n.

The lines in the two spectra are as follows, the wave lengths being given in tenth-mètres, the wave numbers in oscillation frequencies to the mètre:—

Series.	N.	Helium.		Parhelium.	
		Wave Length.	WaveNumber.	Wave Length.	WaveNumber.
Principal.	2	11170·	895100	20400·	490100
	3	3888·785†	25707821†	5015·732	1993181
	4	3187 830	3136041	3964·875	2521448
	5	2945·220	3394359	3613·785	2766409
	6	2829·173	3533582	3447·734	2899641
	7	2763·900	3617028	3354·667	2980082
	8	2723·275	3670983	3296·900	3032296
	9	2696·230	3707804	3258·336	3068183
	10	2677·2	3734158	3231·327	3093828
	11	2663·3	3753645	3211·626	3112806
	12	... ..	.....	3196·81	3127232
	13	.....	.....	.....	.....
	14	.....	.....	3176·6	3147127

Series.	N.	Helium.		Parhelium.	
		Wave Length.	WaveNumber	Wave Length	WaveNumber.
First Subordinate.	3	5875 870*	1701413*	6678·37	1496965
	4	4171·646*	2235697*	4922·096	2031098
	5	4026·342*	2482956*	4388·100	2278263
	6	3819·751*	2617244*	4143·919	2412507
	7	3705·151*	2698192*	4009·417	2493437
	8	3634·393*	2750723*	3926·678	2545975
	9	3587·426*	2786731*	3871·954	2581957
	10	3554·594*	2812473*	3833·710	2607713
	11	3530·646	2831549	3805·900	2626768
	12	3512·65	2846056	3785 031	2641250
	13	3498·78	2857337	3768·95	2652520
	14	3487·87	2866274	3756·24	2661495
	15	3479·10	2873500	.....	.....
	16	3471·93	2879433	.....	.....
	17	3466·04	2884327	.....	.....
	18	3461·4 ?	2888193	.....	.....
	19	3456 9 ?	2891943	.....	.....
Second Subordinate.	3	7065·48*	1414948*	7281·81	1372913
	4	4713·252*	2121094*	5047·816	1980512
	5	4120·973*	2425939*	4437·718	2252789
	6	3867·613*	2584855*	4169·131	2397918
	7	3733·604*	2678061*	4024·136	2484316
	8	3652·121*	2737371*	3936·064	2539904
	9	3599·472*	2777408*	3878·330	2577712
	10	3563·125	2805739	3838·210	2604636
	11	3536·963	2826492	.....	.....
	12	3517·48	2842147	3787 64	2639431
	13	3502·47	2854327	3770·72	2651274
	14	3490·77	2863893	.....	.....
	15	3481·6	2871437	... ..	... ..

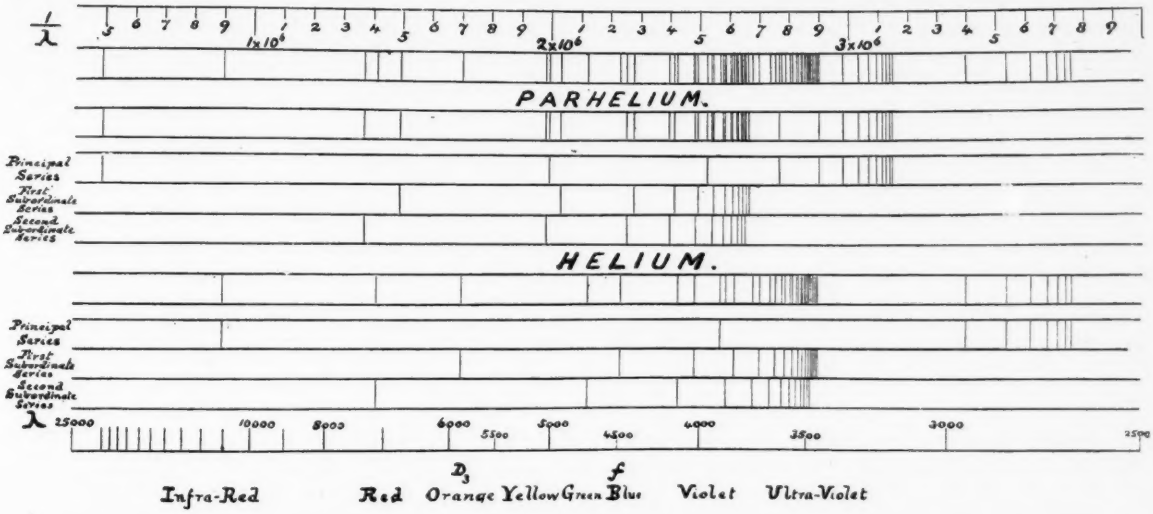
The lines marked with an asterisk are double, each having a faint companion on the redward side, with wave number on the average 100·7 smaller than that of its primary. The line marked with a dagger is possibly double, the companion having a wave length 0·05 larger than that of its primary.

the principal series 1696019, almost exactly the difference of the two. If we turn now to the clèveite gases we find the limits of the two principal series to be 3202986 and 3845532, and the limits of the two pairs of subordinate series 2717188 and 2921116. If we take the difference of the first and third of these numbers, and also of the second and fourth, we have 485798 and 924416 approximating closely to the wave numbers of the first lines in the two principal series. But to take together the first and fourth, and the second and third, would give us wave numbers not represented in the clèveite spectrum at all.

These two leader lines were not discovered until after the six series had been identified. Photography had shown the ordered clusters of lines far in the unseen regions of the ultra-violet, and the sequences so detected evidently had their initial members deep in the equally invisible regions of the infra-red. As the diagrams show, and as the formulæ require, the lines in the violet are crowded together; proceeding towards the red the intervals become very wide. Hence there is no danger in the region of long wave lengths of confusing a line of one series for one of another. The lines here are few, widely separated, and very intense.

elements, had been arrived at considerably earlier by several astronomers from quite different grounds. Prof. Norman Lockyer had been supplied with a helium tube by Prof. Ramsay immediately the latter had made his discovery, and Mr. Lockyer soon provided himself with other tubes filled with gas from bröggerite and uraninite. Then, as he set to work on the examination of the spectrum of the new gas, he found line after line to correspond with lines of unknown origin in the spectrum of the solar chromosphere, and of certain stars and nebulæ, till he concluded that "this gas is really the origin of most, but certainly not of *all*, of the unknown lines which have been teasing astronomical workers for the last quarter of a century."*

But the chromospheric lines thus identified fell into two very different categories. Of the six strongest lines of the clèveite gas spectrum, three, viz., λ 7066, 5876 (D_3), and 4472, are given the frequency number 100 in Young's table of the chromospheric lines; whilst those at λ 6678, 5016, and 4922 have the numbers respectively 25, 30, and 30. Prof. Lockyer, therefore, from the first expressed his opinion that the clèveite gas was not a



So when Profs. Runge and Paschen, following the formulæ which the ultra-violet lines had given, found that $n=2$ for the principal series of "helium" and of "parhelium" would indicate a line in each case far below the limits of visibility in the red, and on searching with the bolometer found each line close to its predicted place, bright, strong, and intense, there was no ambiguity about the result. The actual spectra corresponded to the theoretical, and were complete from their rise far in the obscure regions of the infra-red, till they died away in the darkness which lies on the other side of the visible spectrum. One point which the diagrams fail to indicate is of great significance, viz., the way in which the brightness of the lines in any particular series diminishes as the violet end of the spectrum is approached. The smaller the value of n the brighter the line. Then, too, the principal series is line for line brighter than either of the secondary series; whilst in the particular case of the clèveite gas the various lines of the "helium" spectra are brighter than the corresponding lines of the "parhelium" spectra.

The belief which the two great German physicists had thus reached, that the clèveite gas was a mixture of two simple one but a mixture,† and M. Deslandres was scarcely behind him in arriving quite independently at the same conclusion.‡

It will be observed that the division which solar physicists were led to make was precisely the same as that which Profs. Runge and Paschen had reached by so different a method. Those lines of clèveite gas which Young found "always visible" in the chromosphere are all helium lines, the lines "sometimes visible" are all parhelium lines.

The evidence of stars and nebulæ, so far as it goes, tends to support the same division. Perhaps the strongest instance is afforded us by the early spectrum of Nova Aurigæ. Here, lines λ 5016 and 4922 (both parhelium lines) shone out with great distinctness, whilst the helium

* Lockyer, "The Story of Helium." *Nature*, Vol. LIII., No. 1372, p. 345.

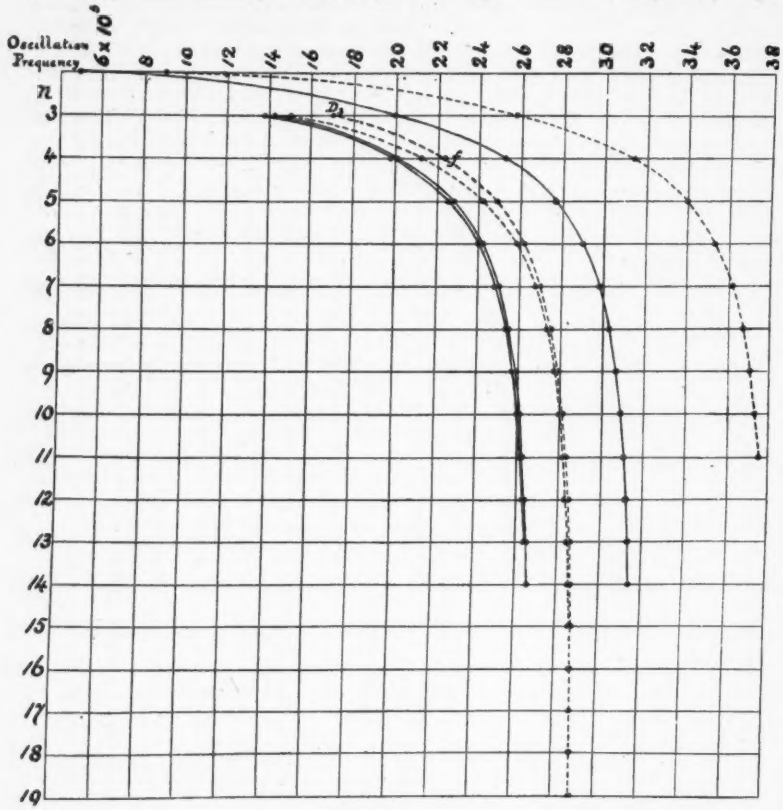
† Lockyer, "On the New Gas obtained from Uraninite;" Second Note. *Proc. Royal Society*, Vol. LVIII., No. 349, p. 113

‡ Deslandres, "Comparaison entre les Spectres du Gaz de la Clèveite et de l'Atmosphère Solaire." *Comptes Rendus*, Tome CXX., p. 1112.

lines were weak. On the other hand, the spectra of nebulæ, rich in lines of origin unknown until identified with those of the clèveite gases, appear to give all the lines of helium within the region thoroughly explored, but only some of its companion element.

The striking peculiarity of the D_3 line, that it is not ordinarily seen dark in the spectrum of the solar disc, is shared by the other lines whose origin has been revealed to us by Prof. Ramsay's discovery. We might reasonably expect, therefore, that those stars where the photosphere alone reveals itself, but not the chromosphere, would fail to show us any indication of these gases. And, accordingly, the Sirian and solar stars, Secchi's first and second types, as a rule, show no indications of the spectra we are considering, though, of course, hydrogen is strongly marked. The two types of fluted spectra, those like α Herculis and the red star type, give little or no indication of hydrogen ordinarily, and hence we should scarcely look to them for the two new gases. But directly we deal with the bright line stars—stars, that is to say, where the chromosphere is able to make its presence felt—then helium and parhelium at once begin to show themselves. β Lyræ, γ Cassiopeiæ, P Cygni, are rich in both gases. In β Lyræ, indeed, the hydrogen lines are outnumbered by those of helium, and parhelium is strongly represented. The Wolf-Rayet stars, on the contrary, are not prolific in the lines of either of the new elements, four only having yet been identified, all apparently belonging to helium.

One subdivision of Secchi's first type shows the helium lines dark on a bright ground. These are the stars in the constellation of Orion, the spectra of which have long been known to be, to so great an extent, negatives of the nebular spectrum; indeed, the line λ 4472, one of the chief helium lines, has been known for some time as, *par excellence*, the Orion line, from its prominence in these spectra. And a careful scrutiny of some hundred and fifty of the brighter stars has yielded to Profs. Vogel and Scheiner about thirty examples of helium spectra outside the constellation of Orion; Spica, Algol, β Tauri, η Ursæ Majoris, γ Pegasi being among the number.* Parhelium is also represented in these stars, but less fully.



To sum up, the spectrum of the new gas proves divisible into two parts, each analogous to the complete spectrum of a distinct element. The behaviour of the two spectra in the laboratory, in the sun, and the other celestial bodies, strongly suggests that they belong to two distinct elements—elements evidently only less light than hydrogen, and having a very similar distribution in nature.

But there is still something to be said on the other side. The two gases have not yet been separated, and the various sources from which they have been prepared have given so nearly the same density for the derived gas—the gas from samarskite giving a density of 2·118, and that from bröggerite of 2·181—as to show that, if they are really two distinct elements, there must be little difference in density between them, and their intermixture in nature must be peculiarly thorough.

There are other points to note. It has been found that by merely varying the pressure it is possible to diminish the brightness of the entire helium series of lines as compared with the entire series of parhelium. Green vacuum tubes—that is, tubes wherein the parhelium giant λ 5016 is predominant—can be prepared in this way, as well as yellow tubes where the helium line D_3 reigns supreme. More curious still, Prof. Ramsay has found that by allowing the gas to diffuse slowly into a vacuum, it was possible to obtain from it a portion of density as low as 1·874 and another as high as 2·133, but in this case the spectrum of the lightest portion was identical with that of the densest. This result appears so puzzling that Prof. Ramsay raises the question as to whether we have the right to assume that the molecules of a gas are homogeneous, and suggests the possibility that he may have separated between the lighter and heavier molecules of a single element.†

We may not, therefore, consider that the existence of the two distinct elements, helium and parhelium, is as yet fully proved. But we certainly may take it as very probable, and in this case Profs. Runge and Paschen give a hint as to the probable density of helium. It will be remembered that D_3 proved to be a close double, and, so far as can be ascertained, the entire helium spectrum is one of close doublets, whilst that of parhelium is of single

* Vogel, "On the Occurrence in Stellar Spectra of the Lines of Clèveite Gas." *Astrophysical Journal*, Vol. II., No. 5, p. 333.

† Ramsay and Collie, "The Homogeneity of Helium and Argon." *Proc. Royal Society*, Vol. LX., No 362, p. 206.

lines. Now, as mentioned in the April paper, any subordinate series of double lines will have a constant difference in wave number between the two members of each doublet, a difference equal to that given by the first doublet of the principal series. This for helium is 100·7, far too small to be shown on the chart. With the alkaline elements the distance apart of the doublets is roughly proportional to the square of the atomic weight. This would give helium an atomic weight between 5·2 and 5·7; parhelium would necessarily be lighter—a view Lockyer challenges, but which would seem borne out by the position of its spectrum, which as a whole lies slightly on the more refrangible side of that of hydrogen; helium lying further in the same direction, and lithium, the next lightest element, further still.

THE FACE OF THE SKY FOR DECEMBER.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS are increasing in number and magnitude. Conveniently observable minima of Algol occur at 11h. 15m. P.M. on the **3rd**, 8h. 4m. P.M. on the **6th**, 9h. 46m. P.M. on the **26th**, and 6h. 35m. P.M. on the **29th**.

Mercury is an evening star towards the end of the month, but his great southern declination will prevent any useful observations in these latitudes.

Venus is also an evening star, but with great southern declination; still she may possibly be observed towards the end of the month. On the **16th** she sets at 6h. 55m. P.M., or more than three hours after sunset, with a southern declination of 21° 11′ (at noon), and an apparent diameter of 15″, just three-quarters of the disc being illuminated. On the **23rd** she sets at 7h. 17m. P.M., or nearly three and a half hours after sunset, with a southern declination of 18° 52′, and an apparent diameter of 15½″. On the **31st** she sets at 7h. 41m. P.M., with a southern declination of 15° 45′, and an apparent diameter of 16¼″, $\frac{7}{10}$ths of the disc being illuminated. During the latter half of December she describes a direct path through Capricornus.

Mars is an evening star, and is very well situated for observation, coming into opposition with the Sun on the **11th**. On the **1st** he rises at 4h. 12m. P.M., or twenty minutes after sunset, with a northern declination of 25° 31′, and an apparent diameter of 17¼″. On the **9th** he rises at 3h. 27m. P.M., with a northern declination of 25° 39′, and an apparent diameter of 17″. On the **16th** he rises at 2h. 48m. P.M., with a northern declination of 25° 39′, and an apparent diameter of 16¾″. On the **23rd** he rises at 2h. 10m. P.M., with a northern declination of 25° 33′, and an apparent diameter of 16″. On the **30th** he rises at 1h. 36m. P.M., and souths at 10h. 7m. P.M., with a northern declination of 25° 25′, and an apparent diameter of 15¼″. During the month he describes a retrograde path in Taurus.

Jupiter is an evening star, and becomes well situated for observation towards the end of the month. On the **23rd** he rises at 9h. 47m. P.M., with a northern declination of 8° 46′, and an apparent equatorial diameter of 45½″. On the **30th** he rises at 9h. 19m. P.M., with a northern declination of 8° 49′. He is almost stationary in Leo during the month. Both Saturn and Uranus are, for the observer's purposes, invisible.

Neptune is an evening star, rising on the **1st** at 4h. 24m. P.M., with a northern declination of 21° 34′, and an apparent diameter of 2·7″. On the **30th** he rises at 2h. 27m. P.M. He is in opposition on the **22nd**, and describes a very short direct path in Leo during the month.

December is a fairly favourable month for shooting stars, the chief showers being those of the Geminids on December **9th** to **12th**, the radiant point being in R.A. 7h., and north declination 32°, rising about 4h. 10m. P.M., and setting at 1h. 40m. A.M.; and of the Andromedes, occurring on the evenings of the **26th** and **27th**, the radiant point being in 1h. 40m. R.A. and north declination 48°.

The Moon is new at 5h. 51m. P.M. on the **4th**; enters her first quarter at 0h. 29m. A.M. on the **12th**; is full at 4h. 5m. A.M. on the **20th**; and enters her last quarter at 0h. 9m. P.M. on the **27th**.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of November Problems.

(E. Henry.)

No. 1.

1. B to B4, and mates next move.

No. 2.

1. Kt to Kt7, and mates next move.

CORRECT SOLUTIONS of both problems received from G. G. Beazley, H. Le Jeune, Alpha, H. S. Brandreth, J. M'Robert, G. J. Newbegin, W. D. F. Edwards, G. H. Herbert, Miss Attwood, E. C. Willis, G. A. F. (Brentwood), A. E. Whitehouse, J. T. Blakemore, W. H. Stead, W. Clugston, J. E. Simpson, A Norseman, A. S. Coulter, E. W. Brook, L. Pfungst, H. W. Elcum, A. C. Tappenden, H. F. Biggs.

Of No. 1 only from Rev. F. W. Quilter, D.D., A. St. J. C., A. P. Hyatt.

A. P. Hyatt.—See answer to A. St. J. C. below.

Alpha.—The fact that this page has to reach the printer by the middle of the previous month will account for the defect.

Rev. F. W. Quilter.—After 1. B to QKt7, Black may play anything safely except K to Q2. Probably, therefore, you intended Kt to Kt7.

A. St. J. C.—If 1. B × P, B moves, there is no mate.

W. Mason.—By several moves of the Kt at B3; in fact, too many.

W. Clugston.—Thanks for enclosures. Mr. Loyd's idea wants working into a three-mover. Shall be glad to insert your two-mover next month.

A. C. Tappenden.—Yes; we have heard it ascribed to Mr. Loyd. It is very neat.

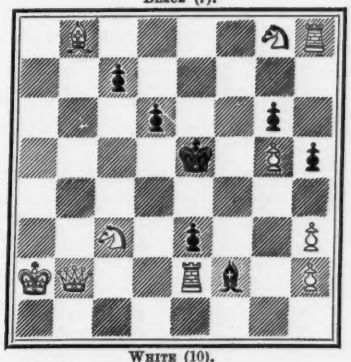
J. T. Blakemore.—Many thanks for the problems, which are very acceptable. One is reserved for next month.

PROBLEMS.

No. 1.

By J. T. Blakemore.

BLACK (7).



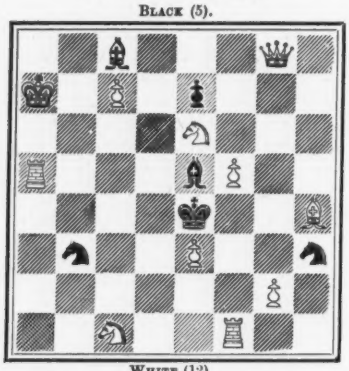
WHITE (10).

White mates in three moves.

No. 2.

By Eugene Henry.

BLACK (5).



WHITE (12).

White mates in two moves.

CHESS INTELLIGENCE.

An attempt is being made to revive the meetings of the Counties' Chess Association, which came to an end a few years ago, chiefly in consequence of the establishment of the British Chess Association. The latter in its turn came to an untimely end, its place being partly filled by the amateur tournament held at Craigside, Llandudno, twice a year. It is in connection with this place of meeting that the Counties' Association will be resuscitated, and it is proposed to hold a "Counties and Craigside Tournament" early in 1897, under the joint management of Messrs. Firth and Skipworth. It is not very clear from the prospectus whether it is intended that all subsequent meetings will be held at Craigside; but, if this is the case, we fail to see how the Counties' Association will be performing the function suggested by its title. In past years the Association changed its place of meeting from year to year, and thus gave the leading provincial players a chance in their turn of attending the meetings without travelling long distances.

By the death of Mr. W. H. K. Pollock, at the age of thirty-seven, Anglo-Canadian chess loses its leading representative, and the *British Chess Magazine* an able contributor.

Mr. Pollock made his first public appearance as a player in the second class of the Counties' Chess Association about fourteen years ago. On that occasion Mr. Pollock took the first prize, without losing a single game, Mr. Locock (who also made his *début* on this occasion) being second. After this Mr. Pollock rapidly rose to the position of an acknowledged expert, and was a regular attendant at the meetings of the Counties' Association (to which he usually went on foot) and other first-class tournaments, both national and international. Though he never took a very high place in these latter, he was always reckoned a dangerous competitor; witness his brilliant victories over Steinitz and Tarrasch in the Hastings Tournament last year.

Outside the chess world Mr. Pollock was a man of educated tastes, a licentiate of the College of Surgeons, and, like Mr. Blackburne, as fond of cricket as of chess. This latter taste he acquired no doubt at Clifton College, where he was educated for a short time, and afterwards at Somersetshire College, Bath.

The Buda-Pesth International Tournament resulted in a win for M. Tchigorin, after a tie with M. Charousek; this is M. Tchigorin's first absolute victory in an international tournament. The scores were:—Tchigorin and Charousek, 8½; H. N. Pillsbury, 7½; Janowski and Schlechter, 7; Wallbrodt and Winawer, 6½; Dr. Tarrasch, 6; Albin and Maroczy, 5; Marco, 4½; Dr. Noa, 4; Popiel, 2.

M. Charousek more than sustained the reputation achieved by him in the Nuremberg Tournament; Herr Maroczy, on the other hand, showing a lamentable falling off. Janowski's score should have been even better than it was, as he threw away one or two points quite unnecessarily. Winawer started well, but failed to maintain his form. Dr. Tarrasch recovered a little from his disastrous start, but comes out very low for the victor in three successive international contests. The remainder occupy their legitimate places.

The Lasker-Steinitz Match is again in progress, Mr. Lasker being now, apparently, willing to play as often as his old opponent likes. But if the first four games of the present match, all lost by Steinitz, are any augury of the final result, we imagine that these matches will at last come to an end, and that Mr. Lasker will find an opponent more nearly in the zenith of his play.

The bound Volume for 1896, with Index complete, will be ready on the 7th December. The Index for the year will be issued as usual in the January Number, which will also contain an eight-page illustrated literary supplement.

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TWO PLATES.—1. Female Giraffe at the Zoological Society's Gardens, London. 2. The Great Group of Sunspots of September 10th—22nd, 1896.

EXTRACT FROM A LECTURE ON "FOODS," BY DR. ANDREW WILSON.—"The consumption of cocoa happily increases year by year. I say 'happily,' because, as tea and coffee are not foods, while cocoa is a true food, any increase in the national nutrition means an increase in the national prosperity. Winter, besides, is close upon us, and I advise those who are susceptible to colds to fortify themselves against chill by attention to their food. The easiest way of effecting this end for many is to substitute cocoa (Epps's being the most nutritious) for tea and coffee."—[*Advt.*]

NOTICES.

The numbers of KNOWLEDGE for January and February of 1894 can now be had, price One Shilling each.

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